TOURIST INFORMATION VOICE SYSTEM (TIVS)

A location aware and feature triggered commentary system for tour groups

Pramod Sharma, Devon Wilson and Stephen Kelly

SUSTAINABLE TOURISM CRC

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National Library of Australia Cataloguing-in-Publication Entry

Tourist information voice system (TIVS) : a location aware and feature triggered commentary system for tour groups / Pramod Sharma, Devon Wilson, Stephen Kelly.

ISBNs: 9781921521317 (pbk.), 9781921521324 (pdf).

Notes: Bibliography.

Subjects: Sightseeing business—Australia—Electronic information resources. Australia—Tours.

Other Authors/Contributors: Wilson, Devon. Kelly, Stephen James, 1970-.

Dewey Number: 338.47910285

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General Manager, Communications and Industry Extension or Publishing Manager, info@crctourism.com.au

First published in Australia in 2009 by CRC for Sustainable Tourism Pty Ltd

Printed in Australia (Gold Coast, Queensland)

Acknowledgements

The Sustainable Tourism Cooperative Research Centre, established and supported under the Australian Government's Cooperative Research Centres Program, funded this research. Map Data Sciences provided map data for field testing. Field testing in WA was only possible thanks to support from Drive WA, who supplied vehicles, accommodation, POI data etc.

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SUMMARY

Tourist Information Voice System (TIVS)

Location Based Services (LBS) are systems which utilise the location of a mobile device, in order to collect or deliver information. They allow for the delivery of location and time specific, personalised, value added services to users on the move. These services include: fleet tracking, concierge services, routing and navigation, emergency services and tour guides. Such services are revolutionising the tourism industry, as they can support the tourist in all three phases of their activity, particularly during the on tour stage. Until such services were developed travellers relied on guidebooks, maps and tourist information centres for their on tour support. LBS can enhance the knowledge and experience of the tourist by providing location and time specific information (e.g. where is the nearest open museum?), as well as offering improved safety (e.g. weather alerts, emergency response etc.). The key here is the delivery of services when consumers need them the most—that is, in unfamiliar environments.

In recognition of the potential of Location Based Services for the tourism industry, this project set out to demonstrate the value of LBS, and to build and evaluate applications for the Australian tourism industry. As part of this project three prototypes were developed, one of which was Tourist Information Voice System (TIVS): application 1. TIVS is a feature triggered, location aware and multilingual commentary system for tour groups, vehicles, boats, pedestrians etc. The stakeholder focus for the application is the tour group travelling in a local physical environment such as a city, national park or tour bus. The mobile technologies enabling it are Global Positioning System (GPS), wireless technology and Geographic Information System (GIS).

As a result of our research we recognised the changing needs of travellers today (taking shorter breaks more often, with limited time to spend planning a trip, wanting greater flexibility during the trip etc.) and the ways in which a mobile commentary system could improve the experience and knowledge of today's tourists. A commentary system offers many advantages over the traditional guide books, maps and tourist information centres. Guidebooks can be very bulky, difficult and heavy to carry around, and one often does not have time to read all the details before or during a trip. Maps can also be a pain to carry around and difficult to follow (especially tourist maps that are not to scale). Tourist information centres are not always open or accessible.

Tourism organisations such as museums and art galleries have offered audio commentaries (cassettes, CDs, MP3 players etc.) for some time, but these also suffer from a number of limitations, namely users must follow a set path, visit features in a set order and are restricted to features included in the audio. Mobile technologies, however, mean that users can be delivered information on features based on their location (e.g. using GPS), can follow any route and visit features in any order. They can receive information on any feature based on their interests, and can easily skip features.

TIVS uses mobile technologies to deliver information on Points of Interest (POIs) according to the interests of the traveller, their location, speed, direction etc. They can view their location on a map, as well as the location of POIs. TIVS delivers audio, images, video and text, in order to enhance the experience and knowledge of tourists. Real time up-to-date information on POIs mentioned in the commentary is another key feature.

Two prototypes were developed as part of this application—a bus tour version for notebook computers and a pedestrian version for small screen devices. These two prototypes differ in terms of their interface and their interactivity. The purpose of the bus tour version was to develop an application for tour groups, allowing members of the group to receive audio commentary in any language. It was developed for notebook computers, and provided the bus has a screen, tourists can also see their location on a map, the location of POIs mentioned in the commentary, images, video, text etc. The purpose of the pedestrian version was to allow individuals to receive audio commentary as they walk around a local environment (i.e. output for a single user).

Bus Tour Version

The bus tour version provides commentary in a tour group situation. In typical group tours, the tour guide can be very hard to hear and understand (especially in urban environments), no matter how close you are to the tour guide, and all members of the group jostle for a position close to the guide. All groups are also given the same commentary. While many audio commentary systems do exist, they are not designed for group tours. TIVS addresses these issues by providing personalised tour commentary to tour groups, whether they are travelling by bus, boat, 4WD etc. The travellers can listen to the commentary using headphones and can also see text, images,

maps etc. via the screen in the vehicle. Each tour will differ according to the interests of the group, the route taken, the speed of the vehicle etc.

Before a tour begins the tour company loads the data for the tour (map data, POI data, music, general commentary) onto the notebook. When the tour group boards the bus, the driver selects the type of tour the group is interested in (e.g. architecture, history, wildflowers etc.) and whether to play music or general commentary when there are no POIs to talk about. The tour then begins and the location of the bus is recorded using GPS. The bus requires an LCD screen with a resolution of at least 1280 x 1024 pixels and a physical size of 17 inches, so that the travellers can view the TIVS interface from anywhere in the bus. The focus of the interface is a map showing the location of the bus and POIs.

For each POI (e.g. Parliament House) a number of attributes/items of commentary (e.g. *This building was built in 1894 on the site of the former ...*) are recorded in the database (as both text and MP3 files). A throw distance is also entered for each POI (i.e. the distance within which the POI should be commented on) and items are weighted according to tour types. Images can also be stored for each POI and their attributes.

Travellers can view their location and the location of POIs mentioned in the commentary on the map. When a POI/item is being mentioned in the commentary it is highlighted on the map and if it has an associated image, this is shown over the map. Audio commentary is received via headsets worn by each member of the group. If MP3 files of the commentary are stored in the database, then these are the audio files delivered to the group. If, however, the attributes are stored as text only, the text-to-speech engine is used. As audio commentary is being delivered, it is also shown as text. The bus driver can also choose to show videos during the tour.

The look ahead algorithm calculates the POIs and the items to include in the commentary (based on the tour type, location of the bus, throw distances, speed, direction etc.). The POIs and items are arranged in a queue and the queue is updated whenever items of commentary are finished or every 15 seconds. TIVS is also able to receive real-time updates to the commentary via GPRS.

During the tour the application records the POIs and items mentioned and this information could be used to create a PDF showing the location of the POIs mentioned during the tour, lists of POIs and their URLs, which can be downloaded from the web (post tour support).

Technologies

The technologies used for the commercial prototype include:

- GPS
- GIS
- Text-to-speech
- GPRS
- Bluetooth
- SQL Server
- Data sync
- .Net framework 2.

Significance

The significance of TIVS is:

- It is a ‘geography smart’ tour guide for tour groups and individuals, delivering audio, text and graphics via mobile devices.
- It is a multi-lingual tour guide (commentary can be delivered in any language, provided the information is recorded in the database in the appropriate language)
- Its delivery of ad hoc commentary incorporates the look ahead algorithm for POI detection this detects and arranges POIs and items in a queue according to tour type, bearing, speed, distance etc.
- On the fly updates can be received via GPRS.

Key Stakeholders

Stakeholders	Benefits
Tourism Organisations	Improved service offerings (superior, value-added, personalised services) Supports the tourist in all three phases of their activity Improved services for group tours Potential source of revenue Improved access to SMTEs and tourism organisations
Tourists	Improves the experience and knowledge of the traveller Personalised, value-added, location and time specific services (Information by: the interests of the group or individual; the location of the tourist/vehicle; able to receive real-time updates via GPRS) Improved safety Improves the experience in a group tour situation Increased satisfaction of the traveller

Advantages

TIVS offers tourists many advantages:

- personalised commentary according to user interests
- commentary in any language (provided information is stored in the database in the appropriate language)
- support for group tours
- improved knowledge of a location (as it delivers information via audio, text, images and video)
- provides greater flexibility to the travellers as they do not have to follow a set route and can choose to visit POIs in any order
- the delivery of *ad hoc* commentary
- the look ahead algorithm determines which POIs and items to mention in the commentary depending on your interests, the speed and direction you are travelling in etc.
- allows for the delivery real-time up-to-date information—on the fly updates
- can be used for any length of tour—a one hour tour or a tour lasting 2 weeks
- application can also be used to train and prompt tour guides

Objectives of the Study

The purpose of the current study was:

- to develop a 'commercial prototype' of TIVS by completing software development, calibration and field testing for application 1 developed as part of project STCRC project 80050;
- to develop a website to support LBS solutions for the Australian travel and tourism industry.

Two prototypes were developed as a result of application 1 (STCRC project 80050): a pedestrian prototype and a bus tour prototype. The bus tour prototype was the one chosen to develop into a 'commercial prototype'. The reason for this choice was the need for support for group tours (an important market for tourism in Australia) and the lack of existing applications in this area.

Methodology

No.	Module	Tasks
1	Interface	Enhancement of map interface Improve timing (e.g. map location every 1 second, features every 3 seconds) Choice of music or general commentary for gaps Pause button
2	Look Ahead Algorithm Decides on the optimum POIs and items to mention during the tour, this will depend on a number of factors such as tour type, bearing, distance, speed etc.	Improvements to efficiency and overall enhancement Field testing and calibration
4	Map Display Draws information on-screen; shows arrows and location of bus	Implement dynamic visualisation effects Allow for 3 zoom levels Fine tuning
5	Speech Plays direction speech on first location item of each POI. Says sound files.	Interface with text-to-speech engine text-to-speech conversion and testing
6	Online Update Allows users to view real-time up-to-date information via GPRS	Application on web server allowing updates to be sent and received Real world testing Implement text-to-speech conversion
7	GPS Reads current location of bus/pedestrian and converts to UTM coordinates	Generalised GPS capture (improve current version by making it more generic and better at handling error corrections) Implement auto-find for GPS devices Change to Mercator owing to problem of crossing UTM zones
8	Trip Log Records POIs and items (trip log in SQLite) mentioned in commentary	Driver can give tour details to tour company via USB, allowing them to develop strategies for post-tour support
9	Video Allows tourists to view short videos on POIs and regions	Ability to run stand alone video Drivers can choose from drop down list – 1 hr, 30 min, 20 min, 10 min videos Support DivX and MPEG Uses Windows Media Player
10	Data Entry Interface Application for entering data on POIs (text, sound files and images) and general commentary	Develop a data entry application for POIs, including localised text and text-to-speech Input POI data for field testing Define general interest areas for general commentary
11	Map Data Preparation Maps show streets, parks, water, land etc.	Obtain map data for QLD and Western Australia Generalise data Manipulate and symbolise data
12	Music Background music to play in periods of silence	Background music (MP3 files) Randomised selection of music using Windows Media Player At least 1 hour of music
13	General	Improve code, scalability, system architecture, performance
14	Field Testing	Detailed testing of calibration and testing on different geographic scales
15	Website Allowing access to online updates; users can download and upload GPS tours; access PDF	Web server for real-time updates
16	Documentation	Technical and user manuals Update diagrams

Key Findings

Field testing of the commercial prototype was carried out in Brisbane and in Western Australia. The application performed very well. Field testing in Brisbane was undertaken largely in the Graceville area, driving in a car, and walking around the park. The application was installed on a notebook computer and required the use of a GPS receiver. While a few small issues were identified, they were quickly rectified, and TIVS was deemed to be ready to be tested during a real tour.

The real-world testing of TIVS was carried out in Western Australia. While this commercial prototype was designed for bus tours, testing in Western Australia was undertaken for tag along tours or global gypsies type tours. Testing was undertaken with Drive Western Australia. These are the types of tours they envisage TIVS being used for. Hence, testing was undertaken in 4WDs with TIVS being used in two of the three vehicles. As the interface was designed for bus tours, so that users could view the screen from the back of the bus, several changes are required for tag along tours in a 4WD.

- Places and roads should be labelled.
- Map data is too generalised.
- Roads layer must be split up into streets, railways etc.
- Interface should have a legend and scale.
- Users should be able to click on places to find out more information—interactive
- Symbolisation needs to be to be changed—colour, line thickness etc. Users can choose different modes offering different symbolisation.
- Interface should include how far travelled.
- Users should be able to zoom in and out.
- Head phones cannot be worn by the driver of the vehicle and are not necessary in this environment.
- FM transmitters improve sound quality.

Initial testing in Western Australia was undertaken in the Swan Valley and TIVS performed extremely well in this local environment. Some issues identified were:

- Throw distances entered were too large and need to be tested (suitable distances vary according to the type of POI and topography). It will take some fine tuning to get this right
- Pre-recorded MP3 files were the better means of delivering audio commentary, as text-to-speech was not natural, missed emphases, was too fast etc.

TIVS was then evaluated during a six day trip from Perth to Geraldton, Carnarvon, Exmouth and back to Perth. This tour encompassed a range of different environments, with varying densities of POIs. The following issues were identified during this trip:

- Battery lives of laptop and GPS were an issue, unless the car has an inverter or a car charger.
- Inverters and car chargers only work while the engine is on.
- A rugged notebook is required.
- Size and weight of notebook.
- Volume was an issue in the car, until we used an FM transmitter.
- The heat emitted by a notebook is a significant problem if the notebook in on someone's lap.
- GPS devices drop out from being unplugged and the computer going to sleep.
- There was a loss of Bluetooth connection between GPS and notebook (unstable).
- Many cables are required—GPS connection, notebook recharger, FM transmitter, camera etc.
- Recharging devices at night—GPS, notebook etc. is a problem if camping.
- Large distances exist between POIs in outback (large areas with no commentary).
- 4WDs are very bumpy and it was difficult to click on buttons under such conditions (buses are more stable and offer a smoother ride).
- Additional commentary is needed on areas where POIs might be (e.g. 'whales can often be seen along the coast ahead' or 'you are entering a wildflower area')—area rather than point features.
- Distances between updates is a significant issue—GPRS coverage is often only available in the towns and so updates for all possible POIs ahead (before the next location where GPRS coverage is available) need to be obtained. How should the update area be defined?
- Road noise is an issue.
- Commentary should include information on topographic features, vegetation, geology etc.
- TIVS should be used to deliver safety information to tourists. This is very important for the Outback.
- The interface should show coordinates in decimal degrees.

Future Actions

The testing of this prototype led to the identification of the significance of TIVS for 4WD tag along type tours. The following enhancements must occur in order to take TIVS to the next stage:

- Interactive version for 4WD/tag along tours needs to be created
- Identify suitable hardware for 4WD use
- Incorporate navigation/routing into TIVS
- Incorporate safety information into TIVS
- Make TIVS more interactive for ease of use
- Incorporate information on hotels; online bookings?
- Add data collected during test in Western Australia to POI database.

Chapter 1

TOURIST INFORMATION VOICE SYSTEM (TIVS)

Background

Location Based Services (LBS) are systems which utilise the location of a mobile device, in order to collect or deliver information. They allow for the delivery of location and time specific, personalised, value added services to users on the move. These services include: fleet tracking, concierge services, routing and navigation, emergency services and tour guides. Such services are revolutionising the tourism industry, as they can support the tourist in all three phases of their activity, particularly during the on tour stage. Until such services were developed travellers relied on guidebooks, maps and tourist information centres for their on tour support. LBS can enhance the knowledge and experience of the tourist by providing location and time specific information (e.g. where is the nearest open museum?), as well as offering improved safety (e.g. weather alerts, emergency response etc.). The key here is the delivery of services when consumers need them the most—that is in unfamiliar environments.

While these services are predominantly consumer services, consumers are also driving the adoption of such services in the workplace. Mobility is the future of business and consumer services and the most successful players will be those that allow consumers to be mobile and connected. Consumers are driving the demand for access to information, services and applications anywhere, anytime. Such mobile applications offer users a more efficient and cost effective means of performing existing tasks (Peterson 2007). Tourism is just one area in which LBS can improve the user's experience and knowledge.

The on tour support of the traveller, has traditionally been through the use of printed guide books, maps, tourist information centres and tour guides. Printed guidebooks, however, are heavy and bulky to carry around, and are difficult to read whilst on the move and still see the sights. Furthermore, many travellers do not have the time to read a guidebook before or during a trip. and Maps can also be awkward to carry around and difficult to follow (especially tourist maps that are not to scale). Tourist information centres are not always open or accessible. With regard to tour guides, tours are conducted in groups with everyone jostling to see and hear; the commentary can be difficult to hear and understand; each group receives the same commentary.

In order to address some of these issues, many tourism organisations have developed audio commentaries for individuals (cassettes, CDs, MP3 players etc.) for museums, historic sites, exhibitions etc. These audio commentary systems, however, still require customers to follow a set route and to keep pace with the commentary (or stop and start the audio). It is difficult to skip exhibits or items and many items of interest are not mentioned. While commentary can be provided in different languages, all users receive the same commentary regardless of their interests (e.g. Tourcaster, Tours by MP3, Tour Mate etc.).

In recognition of these limitations and the changing needs of tourists (taking shorter breaks more often, with limited time to spend planning a trip, wanting greater flexibility during a trip etc.), a new range of audio tour guides have been developed, which deliver audio commentary based on the location of the customer. The location of the traveller is identified using a variety of means, including GPS, infrared, Bluetooth and RFID technology. These audio guides allow users to choose their own route, view exhibits in any order and to move at their own pace (e.g. Travel by GPS Tour Guides, Audio Augmented Reality, BEATS, Frontier GPS Tour Guide etc.). Owing to advances in mobile technology and the increased consumer demand for services anywhere, anytime, a number of these audio guides now offer personalised and location aware audio commentary (personalised according to interests, language preference etc.). Some also allow access to multimedia content via small screen devices (e.g. Antenna Audio, ATS Heritage Audio Tours, Node Explorer Multimedia Tour Guide). These new guides recognise the importance of visual content.

TIVS was developed in this context and is the culmination of several STCRC projects. The purpose of the project #70164 was to carry out a scoping study for the use of Location Based Services for the Australian Tourism Industry. This study examined the potential of LBS, existing prototypes and applications, and the challenges and limitations associated with the development of such applications. As a result of this scoping study several potential application areas were identified. The purpose of project #80050 was to develop and evaluate applications identified in project #70164. Three LBS prototypes (and a supporting application) were developed and evaluated. TIVS was one of these.

The objective was to develop and evaluate a position-based commentary system, including feature-triggered commentary for exhibitions, tour vehicles, buses, pedestrians etc. TIVS is a feature triggered multi-lingual tour guide for tour groups and individuals in a local environment (e.g. Brisbane). It uses GIS, GPS and wireless technologies in order to support the tourist in the on-tour phase of their activity. The aim of the application is to enable travellers to receive audio commentary based on their location. Travellers can also view their location and the location of POIs on a map. As a tour group or individual travels around a local environment, the location of the bus or tourist is recorded using GPS and TIVS delivers audio commentary to individuals based on their location (proximity to various POIs) and interests (tour type). For example, a user may specify architecture as their primary interest, in which case the commentary will give a higher weighting to such information.

The application not only allows for the delivery of location specific and personalised information, but also organises the commentary on the POIs in a queue, in order to optimise the delivery of suitable information. TIVS uses mobile technologies to deliver information on POIs according to the interests of the traveller, their location, speed, direction etc. TIVS delivers audio, images, video and text, in order to enhance the experience and knowledge of tourists. Real time up-to-date information on POIs mentioned in the commentary is another key feature.

Two TIVS prototypes were developed for project #80050—a bus tour version for notebook computers and a pedestrian version for small screen devices. These two prototypes differed in terms of their interface and their interactivity. The purpose of the bus tour version was to develop an application for tour groups, allowing members of the group to receive audio commentary in any language. It was developed for notebook computers, and provided the bus has a screen, tourists can see their location on a map, the location of POIs mentioned in the commentary, images, video, text etc. The purpose of the pedestrian version was to allow individuals to receive audio commentary, images, video, text etc. as they walk around a local environment (i.e. output for a single user).

The objectives of this current study (the subject of this report) were:

- to develop a ‘commercial prototype’ of TIVS by completing software development, calibration and field testing for application 1 developed as part of project #80050;
- to develop a website to support LBS solutions for the Australian travel and tourism industry.

The bus tour prototype was the one chosen to develop into a ‘commercial prototype’. The reason for this choice was the need for support for group tours (an important market for tourism in Australia) and the lack of existing applications in this area.

Bus Tour Version

The bus tour version provides commentary in a tour group situation. In typical group tours the tour guide can be very hard to hear and understand (especially in urban environments), no matter how close you are to the tour guide and all members of the group jostle for a position close to the guide. All groups are also given the same commentary. While many audio commentary systems do exist, they are not designed for group tours. TIVS addresses these issues by providing personalised tour commentary to tour groups, whether they are travelling by bus, boat, 4WD etc. The travellers can listen to the commentary using headphones and can see text, images, maps etc. on the screen of the bus/laptop. Each tour will differ according to the interests of the group, the route taken, the speed of the vehicle etc.

Before a tour begins the tour company loads the data for the tour (map data, POI data, music, general commentary) onto the notebook. When the tour group boards the bus the driver selects the type of tour the group is interested in (e.g. architecture, history, wildflowers etc.) and whether to play music or general commentary when there are no POIs to talk about. The tour then begins and the location of the bus is recorded using GPS. The bus requires an LCD screen with a resolution of at least 1280 x 1024 pixels and a physical size of 17 inches, so that the travellers can view the TIVS interface from anywhere in the bus. The focus of the interface is a map showing the location of the bus and POIs.

For each POI (e.g. Parliament House) a number of attributes/items of commentary (e.g. *This building was built in 1894 on the site of the former ...*) are recorded in the database (as both text and MP3 files). A throw distance is also entered for each POI (i.e. the distance within which the POI should be commented on) and items are weighted according to tour types. Images can also be stored for each POI and their attributes.

Travellers can view their location and the location of POIs mentioned in the commentary on the map. When a POI/item is being mentioned in the commentary it is highlighted on the map and if it has an associated image, this is shown over the map. Audio commentary is received via headsets worn by each member of the group. If MP3 files of the commentary are stored in the database, then these are the audio files delivered to the group. If, however, the attributes are stored as text only, the text-to-speech engine is used. As audio commentary is being delivered, it is also shown as text. The bus driver can also choose to show videos during the tour.

The look ahead algorithm calculates the POIs and the items to include in the commentary (based on the tour type, location of the bus, throw distances, speed, direction etc.). The POIs and items are arranged in a queue and the queue is updated whenever an item of commentary is completed or every 15 seconds. TIVS is also able to receive real-time updates to the commentary via GPRS.

During the tour the application records the POIs and items mentioned during the tour and this information could be used to create a PDF showing the location of the POIs mentioned during the tour (including lists of POIs and their URLs), which can be downloaded from the web (post tour support).

Environment

The tourist environment covered by this application is the local tourist environment, such as Brisbane, the Blue Mountains, the Gold Coast, a national park or tour bus. Currently the application is restricted to outdoor environments, owing to the positioning technology used (i.e. GPS).

Technologies

The technologies used for the commercial prototype include:

- GPS
- GIS
- Text to speech
- GPRS
- Bluetooth
- SQL Server
- Data sync
- .Net framework 2.

Stakeholders

The stakeholder focus for this ‘commercial prototype’ is the **tour group** travelling in a **local** physical environment such as a national park or tour bus. This application will allow tourism organisations and SMTEs to provide superior tours to travellers. In particular, it allows tour companies offering guided tours to enhance their services through the delivery of feature triggered commentary in any language.

The stakeholders are:

- Tourism organisations and SMTEs offering guided tours for tour groups
    - Bus
    - Train
    - Boat
    - Etc.

TIVS offers many advantages to both tourism organisations and travellers (business and leisure travellers).

Stakeholders	Benefits
Tourism Organisations	• Improved service offerings (superior, value-added, personalised services) • Supports the tourist in all three phases of their activity • Improved services for group tours • Potential source of revenue • Improved access to SMTEs and tourism organisations
Tourists	• Improves the experience and knowledge of the traveller • Personalised, value-added, location and time specific services (information by: the interests of the group or individual; the location of the tourist/vehicle; able to receive real-time updates via GPRS) • Improved safety • Improves the experience in a group tour situation • Increased satisfaction of the traveller

Advantages

TIVS offers tourists many advantages:

- Commentary can be personalised according to user interests.
- Commentary can be in any language (provided information is stored in the database in the appropriate language).
- Group tours are supported.
- Location knowledge is improved (as it delivers information via audio, text, images and video).
- It provides greater flexibility to the travellers as they do not have to follow a set route and can choose to visit POIs in any order.
    - The delivery of *ad hoc* commentary
- The look ahead algorithm determines which POIs and items to mention in the commentary depending on your interests, the speed and direction you are travelling in etc.
- It allows for the delivery real-time up-to-date information—on the fly updates.
- It can be used for any length of tour—a one hour tour or a tour lasting two weeks.
- The application can also be used to train and prompt tour guides.

Significance

TIVS offers a unique service to tourists in many ways. It is quite different to other LBS applications for the tourism industry in that:

- It is a 'geography smart' tour guide for tour groups and individuals.
- It delivers audio, text and graphics via mobile devices.
- It is a multi-lingual tour guide (commentary can be delivered in any language, provided the information is recorded in the database in the appropriate language).
- It allows for the delivery of ad hoc commentary.
- It allows for on-the-fly updates (synchronisation) via GPRS.
- The Look ahead Algorithm for POI detection detects and arranges POIs and items in a queue according to tour type, location, bearing, speed, distance etc.

The application was also written in-house, eradicating the need to publish third party libraries. Hence, it offers greater flexibility in the pricing of the final product.

Purpose of Report

This report is intended for STCRC, in order to provide information on the 'commercial prototype' of TIVS—what the application can do, its purpose and significance, how it works; as well as technical information on the system, in particular the modules, their role, issues and scope. This report also discusses the results of field tests in Queensland and Western Australia, as well as future enhancements required for tag along type tours.

Chapter 2

METHODOLOGY

No.	Module	Tasks
1	**Interface**	• Enhancement of map interface • Improve timing (e.g. map location every 1 second, features every 3 seconds) • Choice of music or general commentary for gaps • Pause button
2	**Look Ahead Algorithm** Decides on the optimum POIs and items to mention during the tour, this will depend on a number of factors such as tour type, bearing, distance, speed etc.	• Improvements to efficiency and overall enhancement • Field testing and calibration
4	**Map display** Draws information on-screen; shows arrows and location of bus	• Implement dynamic visualisation effects • Allow for 3 zoom levels • Fine tuning
5	**Speech** Plays direction speech on first location item of each POI. Says sound files.	• Interface with text-to-speech engine • text-to-speech conversion and testing
6	**Online Update** Allows users to view real-time up-to-date information via GPRS	• Application on web server allowing updates to be sent and received • Real world testing • Implement text-to-speech conversion
7	**GPS** Reads current location of bus/pedestrian and converts to UTM coordinates	• Generalised GPS Capture (improve current version by making it more generic and better at handling error corrections • Implement auto-find for GPS devices • Change to Mercator owing to problem of crossing UTM zones
8	**Trip log** Records POIs and items (trip log in SQLite) mentioned in commentary	• Driver can give tour details to tour company via USB, allowing them to develop strategies for post-tour support
9	**Video** Allows tourists to view short videos on POIs and regions	• Ability to run stand alone video • Drivers can choose from drop down list—1 hr, 30 min, 20 min, 10 min videos • Support DivX and MPEG • Use Windows Media Player
10	**Data Entry Interface** Application for entering data on POIs (text, sound files and images) and general commentary	• Develop a data entry application for POIs, including localised text and text-to-speech • Input POI data for field testing • Define general interest areas for general commentary
11	**Map Data Preparation** Maps show streets, parks, water, land etc.	• Obtain map data for Queensland and Western Australia • Generalise data • Manipulate and symbolise data
12	**Music** Background music to play in periods of silence	• Background music (MP3 files) • Randomised selection of music using Windows Media Player • At least 1 hour of music

No.	Module	Tasks
13	**General**	• Improve code, scalability, system architecture, performance
14	**Field Testing**	• Detailed testing of calibration and testing on different geographic scales
15	**Website** Allowing access to online updates; users can download and upload GPS tours; access PDF	• Web server for real-time updates
16	**Documentation**	• Technical and user manuals • Update diagrams

Chapter 3

COMMERCIAL PROTOTYPE

Industry Partners

SJK Consulting; Drive Western Australia

Specifications

The technologies used for the prototype include GIS software (MapWinGIS), GPS receivers, notebook computers and GPRS. The Master database is in SQL Server; the applications uses SQLite, Bluetooth, data sync and was written in Visual Studio.net using .Net framework 2. The software for visualising the data and reading GPS locations was written in-house. The GPS receiver is important for identifying the location of the bus or tourist. The prototype also supports both the unconnected and connected mobile tourist. The unconnected mobile tourist is unable to receive real-time data updates during the tour. In areas where users have access to a wireless network (GPRS), they are able to received real-time up-to-date information and so are 'connected' mobile tourists. The coverage of wireless networks is a major issue for this application (see below).

Interface

The interface for the bus tour prototype was developed for a notebook computer (see Figure 1). The assumptions made are that the bus has an LCD screen with a minimum resolution of 1280 x 1024 pixels and a minimum size of 17 inches. The focus of the screen is a map showing the location of the bus, the location of POIs (in blue); the last POI featured in the commentary (in yellow) and the current POI featuring in the commentary (in red); as well as yellow and red arrows pointing to the last POI featured in the commentary (yellow) and the current POI featuring in the commentary (red). The location of the bus is recorded by GPS (every second) and the map is updated every three seconds. The map faces the same direction as the bus (rather than north) and the map data includes the street network, parks, rivers, railway lines, towns etc. There are three zoom levels and the zoom level chosen will depend in the speed of the bus, but users can also select a particular zoom level (see Figure 2). The interface also includes the time and a summary of what has been said. The commentary can be provided in any language, provided the data is entered in the database in the appropriate language, although labels, menus etc. are currently in English only. Whenever the system comments on a POI, it records the location of the vehicle, the POI and item ID, and the time in a trip log (database table).

For this prototype the bus driver will be required to turn on the laptop, open the application, connect to the GPS, enter the tour type required for the tour group and choose whether to play music or general commentary in periods of silence (see Figure 3). The interface is fairly simple, to make it easy for the bus driver. The tour companies who choose to use this system will be given a detailed manual on how to set it up (i.e. a user manual). They will also have the option of having the application set up for them for a fee, although they will have to enter their own tour information (tour types, POIs, throw distances and attributes).

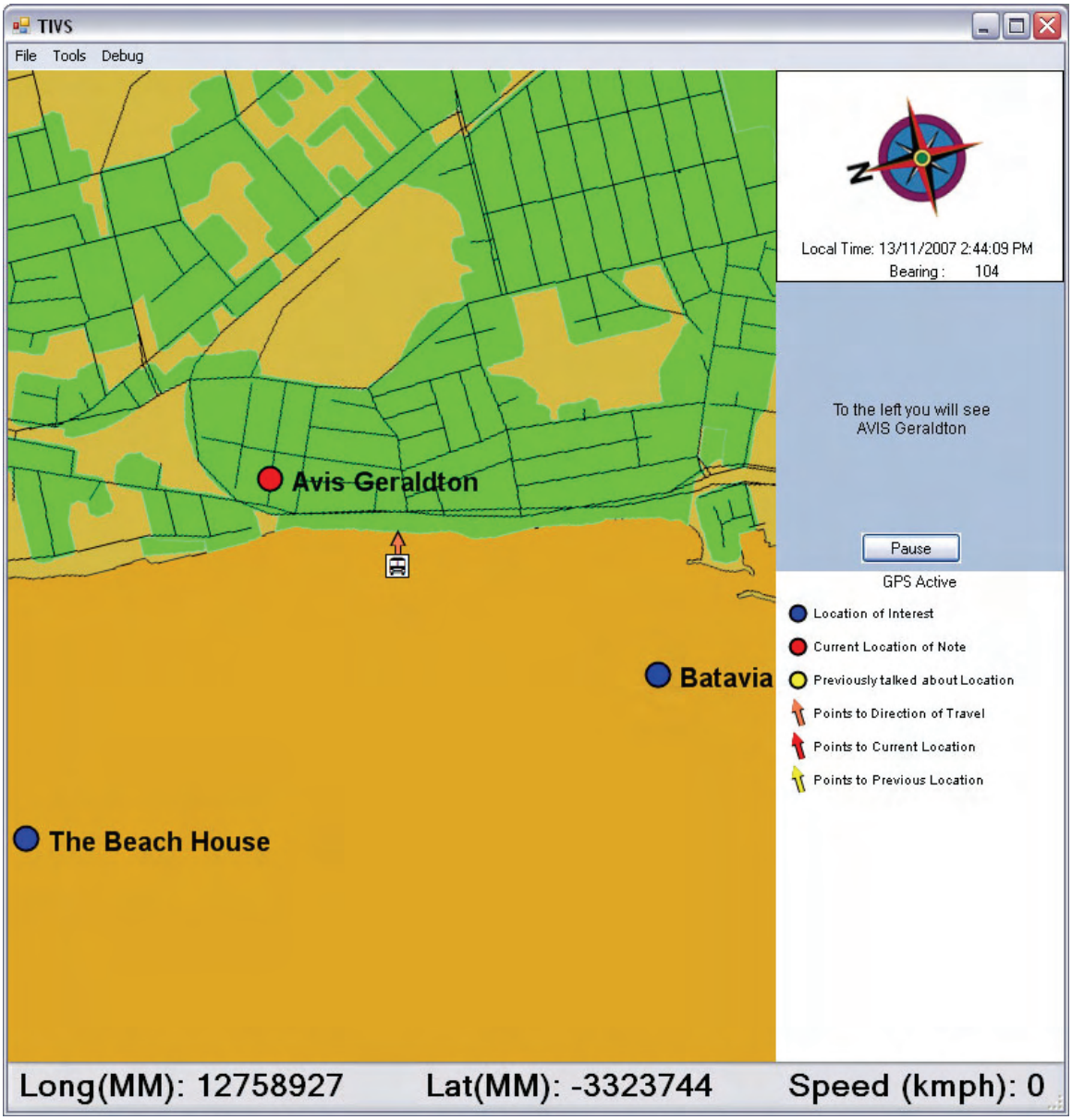


Figure 1: Interface for Bus Tour Prototype

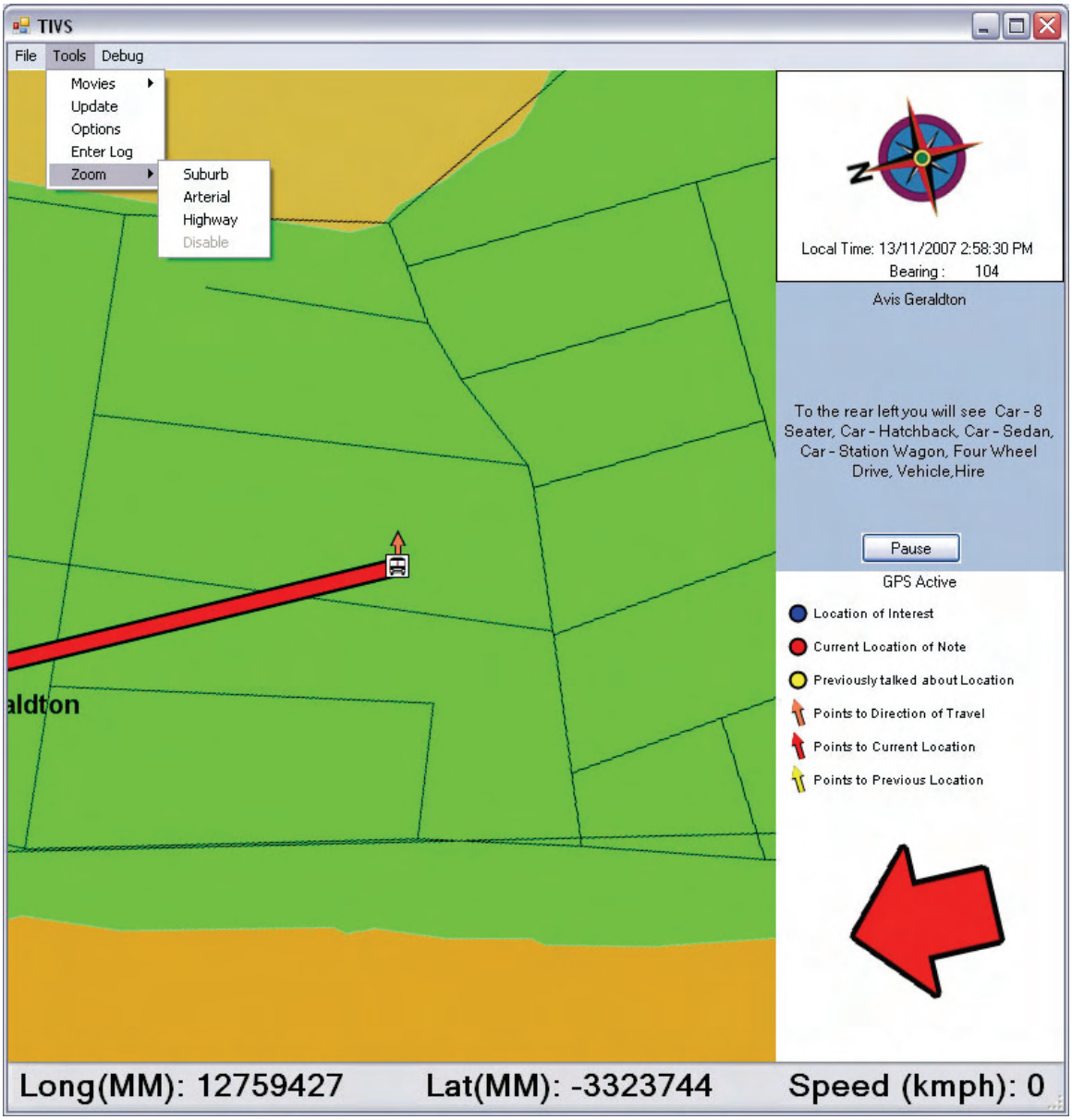


Figure 2: Selecting the Zoom Level

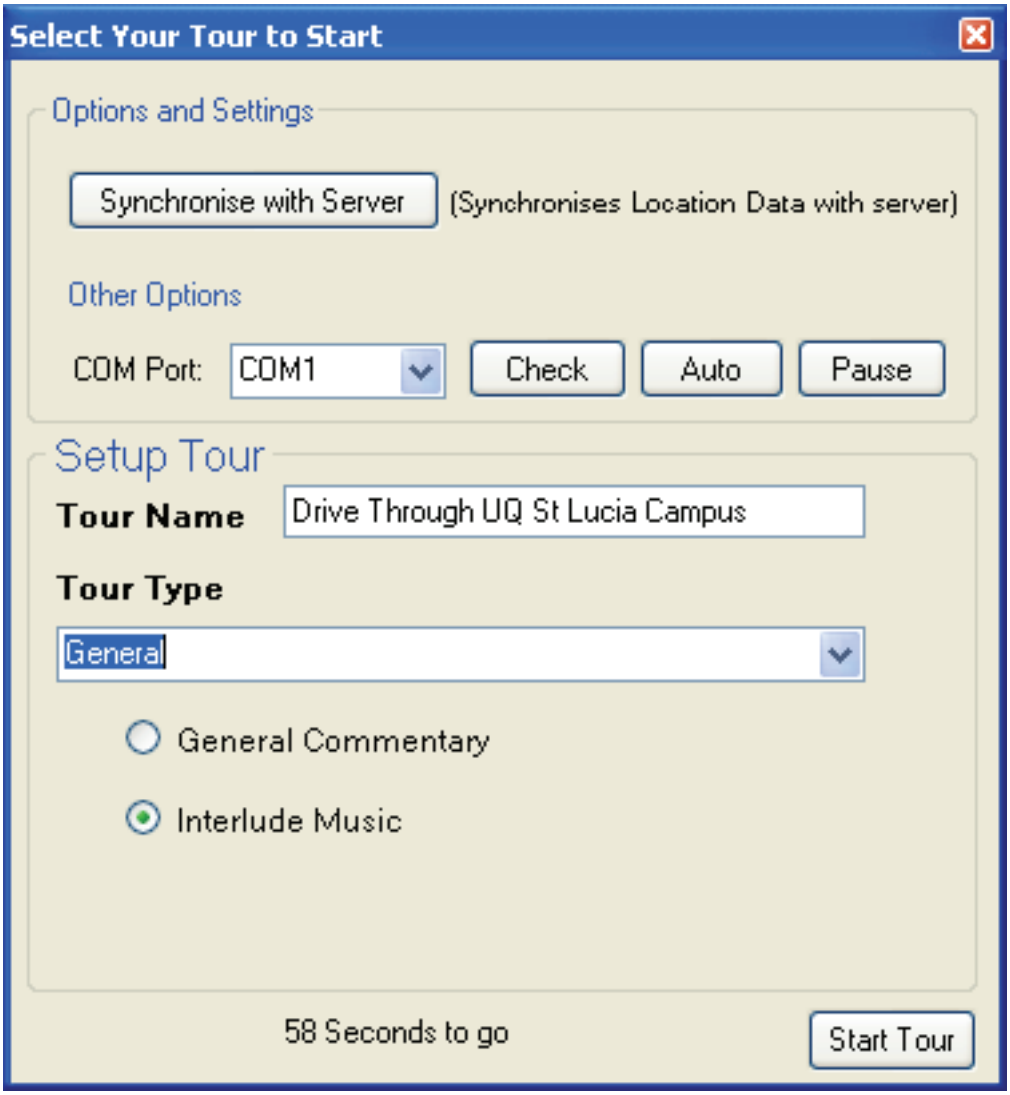


Figure 3: TIVS Laptop Settings

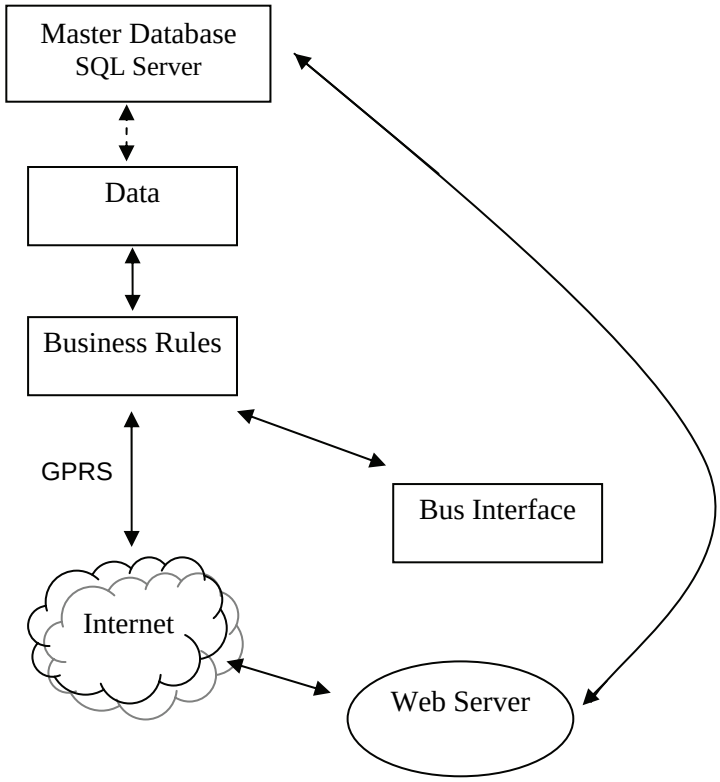


Figure 4: System Architecture

Chapter 4

STORY BOARD

Pre-Tour

The tour company must load the data for the tour. This includes the map data (streets, landuse, rivers), POI data (tour types, POIs, their coordinates, URLs, items of commentary, images, MP3 files), videos, general commentary and music. The recommended maximum per POI is 1.5 MB (650 POIs/GB or 6500 POIs per 10 GB).

Data Updates

The whole database should be replaced/updated each month, preferable using a USB drive rather than a wireless network. If any POIs or items change then the whole database must be updated. The application is also able to receive real-time updates based on the location of the tour vehicle. An application on a central server allows for updates to be received and sent. They are text only and delivered using text-to-speech.

Start Tour

When the tour starts (when the group boards the bus), the driver selects the tour type (architecture, wildflowers, history, shopping etc.) and whether to play the general commentary or music during gaps in commentary of over two minutes. When the tour begins the location of the bus is recorded using GPS.

Preamble

The first POI in the database is a 'fake' POI designed to trigger an introduction to the tour (pictures, images and audio). Its location is chosen so that the introduction will not interfere with the commentary to come. When the bus reaches the throw of this POI, the introduction is triggered.

Throw Distance

Each POI has a specified throw distance, which is entered into the POI database. This is the distance within which the POI should be commented on (see Figure 5). For example, the throw distance of a restaurant may be 200 m and the throw distance for a vineyard 600 m. The distance chosen will depend on the type of POI and the topography. The recommended minimum throw is 100 m and the recommended maximum is 40 km (e.g. for a mountain). If the vehicle does not enter the throw distance, the POI will not be mentioned.

These distances must be carefully chosen and may need fine tuning by the tour company. If inappropriate distances are entered, the POI may not be commented on despite the close proximity of the vehicle, or the item may be commented on even though the POI is some distance away on the other side of the river and cannot be seen.

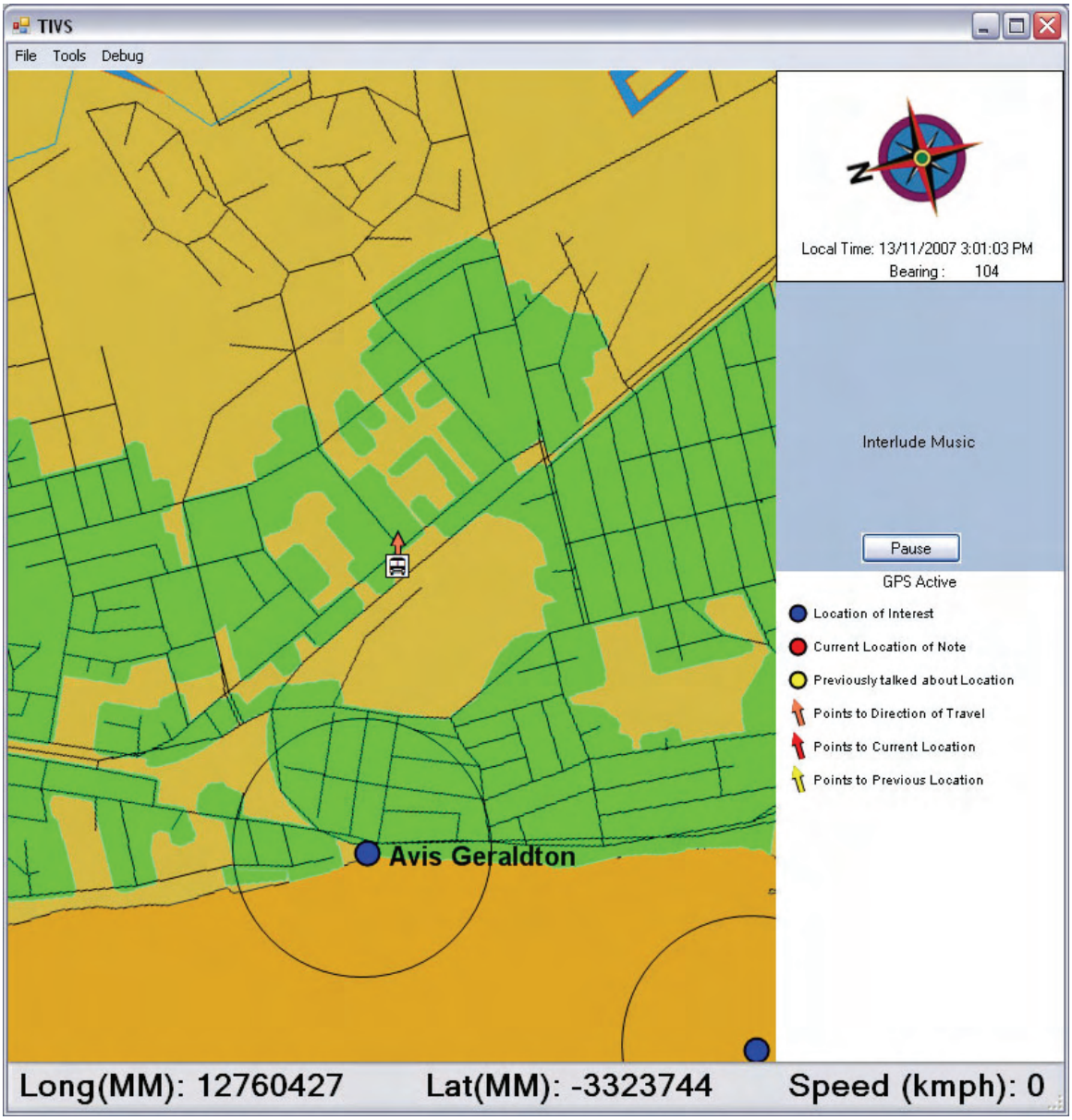


Figure 5: Interface with Throw Distances Shown

On Tour

As the bus continues along its route, the system calculates which POIs and items to include in the commentary. If there are no POIs for the next two minutes, the overview map is shown (Level 3). If after two minutes there are still no POIs, the system will play music or the general commentary. At least one hour of music should be stored as individual MP3 files. The music is then randomly selected by the system. When the system identifies POIs and items to include in the commentary, the map switches to a more localised map and the music or general interest commentary stops.

The commentary for each POI is stored in a master database. For each POI a number of attributes/items of commentary are recorded (we have been using a maximum of 10, but any number can be used). The title of the POI is treated as an attribute and the database records commentary as text and MP3 files. If it is stored as MP3 files then they are used to deliver audio commentary. Each sound file can be up to 15 seconds. If the commentary is stored as text only, then the text-to-speech engine is used (text-to-speech should also be up to 15 seconds). POIs and items of commentary are also weighted according to tour type.

The Look Ahead Algorithm calculates which POIs and items to include in the commentary. The POIs and items are arranged in a queue and the queue is updated whenever an item has finished being commented on (or every 15 seconds). If the sound file is only six seconds long, then the algorithm is recalculated after six seconds. The system calculates which POIs to include in the commentary based on the location's default value, tour type

modifier, bearing, distance, throw distance etc. (see Appendix A). The items of commentary on the POI are chosen based on the POI's final value, tour type modifier and the location items default value (see Appendix A). There are up to 30 factors which could be used and the algorithm relies on precise trigonometry (see Appendix B). Once a location's item ranking is less than the ranking of the next POI's first item, that POI will no longer be discussed and commentary on the next POI will begin (see Appendix A). Tenacity values determine how far ahead the system will look and the default is 2 minutes (8 x 15 second slots). The system will try to fill the entire queue with commentary. Nor is commentary on POIs repeated during a single tour. If the vehicle is stopped (e.g. at traffic lights) the commentary will continue to play, but if it stops for more than 2 minutes, the general commentary or music will play.

There is potentially a photograph or image associated with each item in the database. It is important to have a photograph of each POI to help tourists identify the POI being commented on. Recommended image size is a maximum of 100 kb. If a photo is associated with a POI, then it will be shown over the map.

The bus is also able to receive real-time updates to the commentary via GPRS (e.g. *the tiger exhibit at Dream World is closed for the day*). The system looks for updates within a certain distance or geographical box (5 minutes ahead) and checks for updates every two minutes. The coordinates of the vehicle are sent to the server and the server then searches for updates and sends the text to the bus. Updates are text only (maximum of 150 characters) and the text-to-speech engine converts it to audio (15 seconds maximum). If there is no GPRS coverage, then no updates can be received. There is only one update per POI and once it is said, it is thrown out (not cached). Not all updates sent to the vehicle will be said, as they may not all fall within the area for which commentary is calculated. The tour/bus company must have suitable GPRS plans to allow for updates.

General Interest Commentary

The general interest commentary is general commentary on a region such as Brisbane, the Gold Coast or Perth and can include any information on the region such as demographics, history, vegetation, weather etc. It will only be played if the driver of the vehicle selects to play general interest commentary when there are gaps in the commentary of more than two minutes.

Each state is divided into non-overlapping boxes, with boxes equating to tourism regions (see Figure 6). General commentary for each region is recorded in the POI database and audio should be recorded in a different voice to the POI data, to allow travellers to distinguish between the two commentaries. The general interest commentary for each tourism region should contain at least 100 items (each up to 15 seconds). If the audio is recorded as MP3 files then they will be said, otherwise the text-to-speech engine will be used. Once items of general interest commentary are said, they cannot be repeated within one hour. In this case, music will play in the meantime.

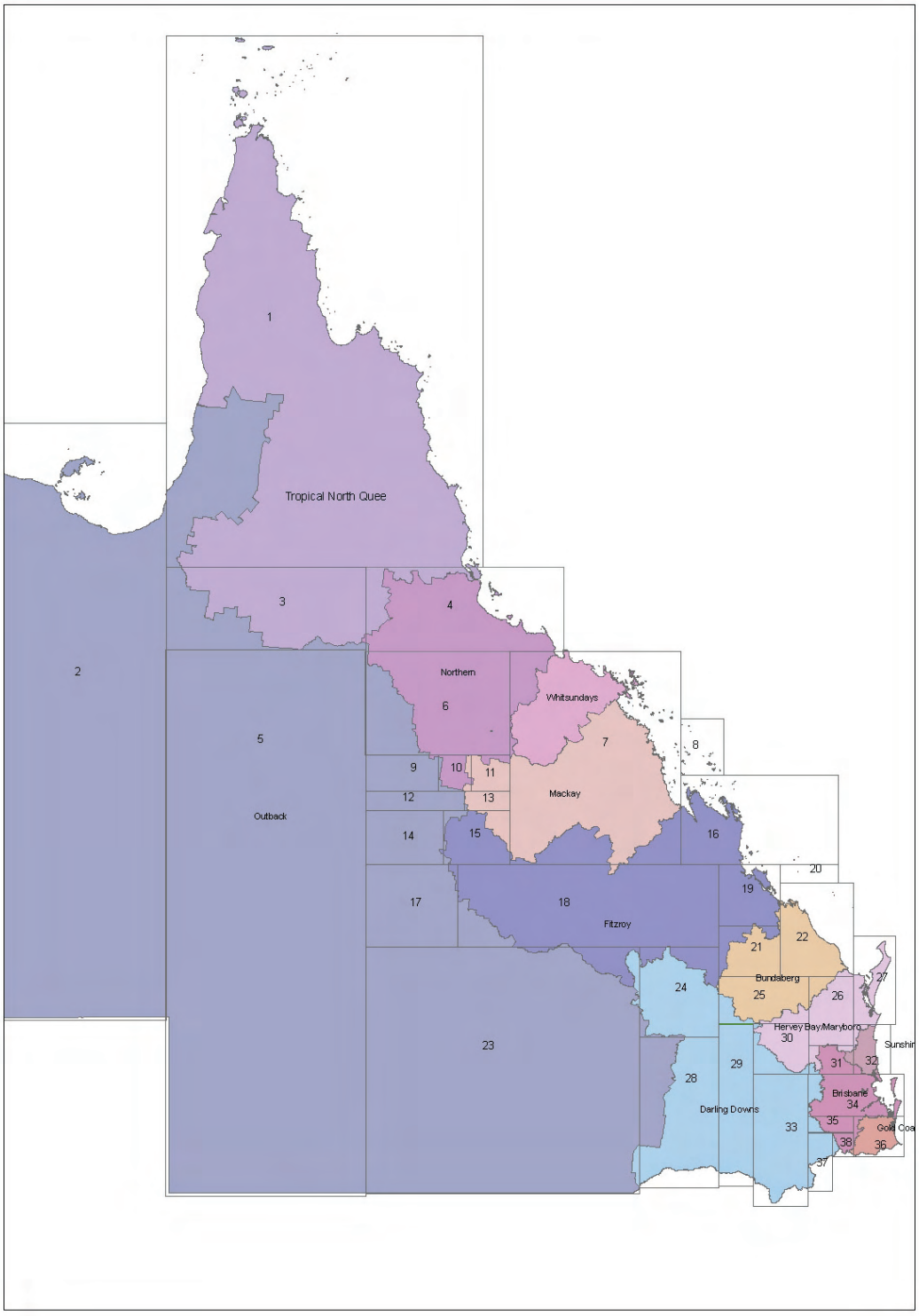


Figure 6: General Interest Boxes

In a single tour, the vehicle may travel through several general interest regions and the system will deliver the commentary relevant to the location of the bus. When the general interest commentary is being played the map will be displayed at Level 2. Images may also be attached to each item in the general interest commentary and will be displayed over the map.

Breaks

During the day the bus may stop at a number of locations to allow the tour group to get out of the bus, view the sights, buy refreshments etc. For this reason a pause button has been included on the interface to pause the commentary (see Figure 1). When the group is ready to resume the commentary they click on the pause button again. If the pause button is not used, then the commentary for the current location will be said and after 2 minutes of silence either the music or general interest commentary will start.

Long Range Location

If the vehicle is within the throw of a long range location (a feature with a large throw distance), such as a mountain, then the system will wait until the queue is empty before inserting it in the commentary. If there is nothing else to say the system will comment on all items straight away. If the system is busy, however, it will wait until there is space into which to insert the commentary. The closer the vehicle is, the less space it will look for (e.g. at 10 km the system looks for 10 items, at 9 km for 9 items etc.). Once the vehicle is within 5 km it is treated as a normal feature.

Video

Tourists can also view videos as they travel around. Drivers can choose from 1 hour, 30 minute, 20 minute or 10 minute videos. DivX and MPEG formats are supported and videos are played using Windows Media Player.

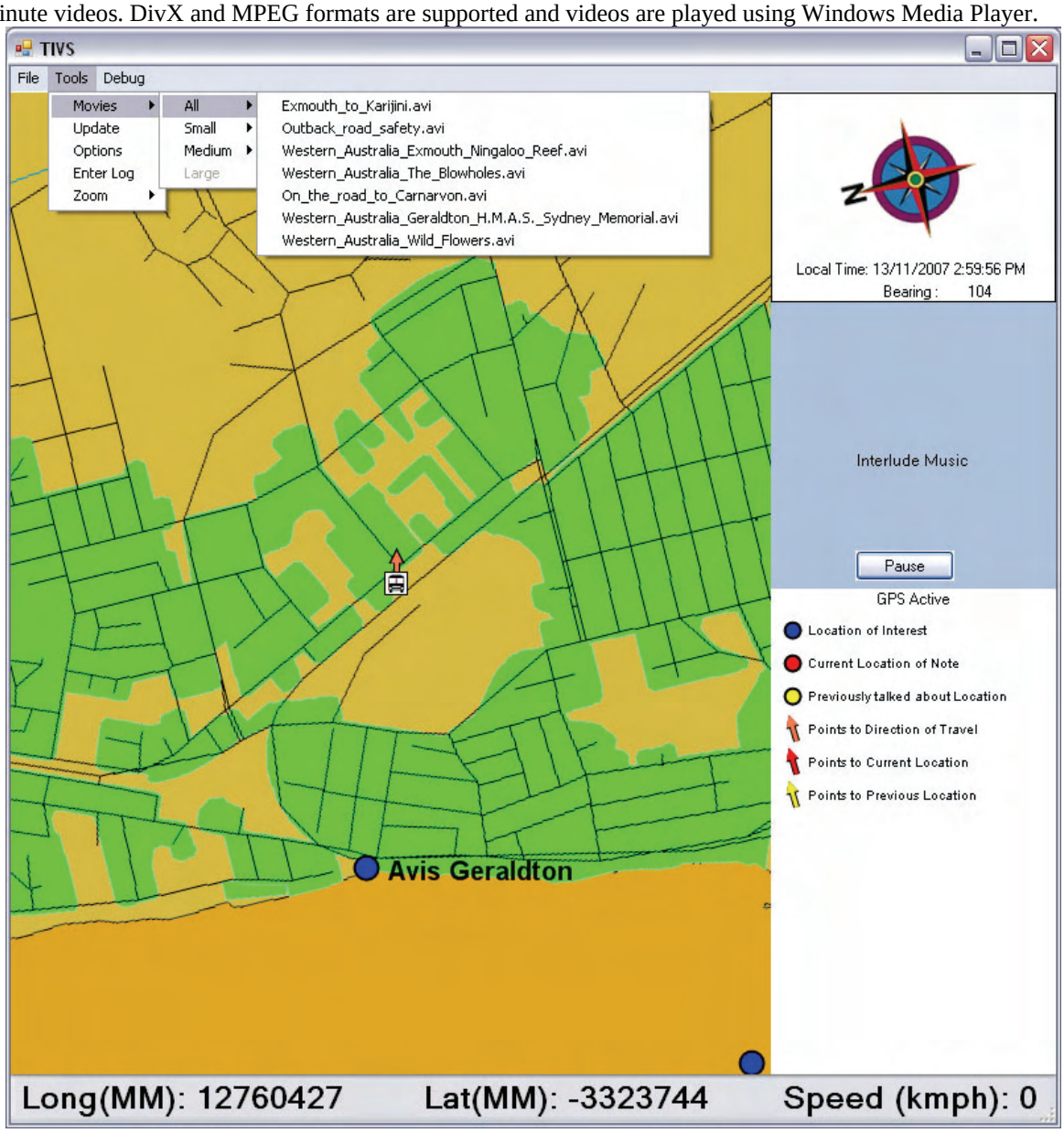


Figure 7: Selecting Videos

New Log

Users can also record information on their current location (Tools—Enter Log); for example, recording the location of a good restaurant.

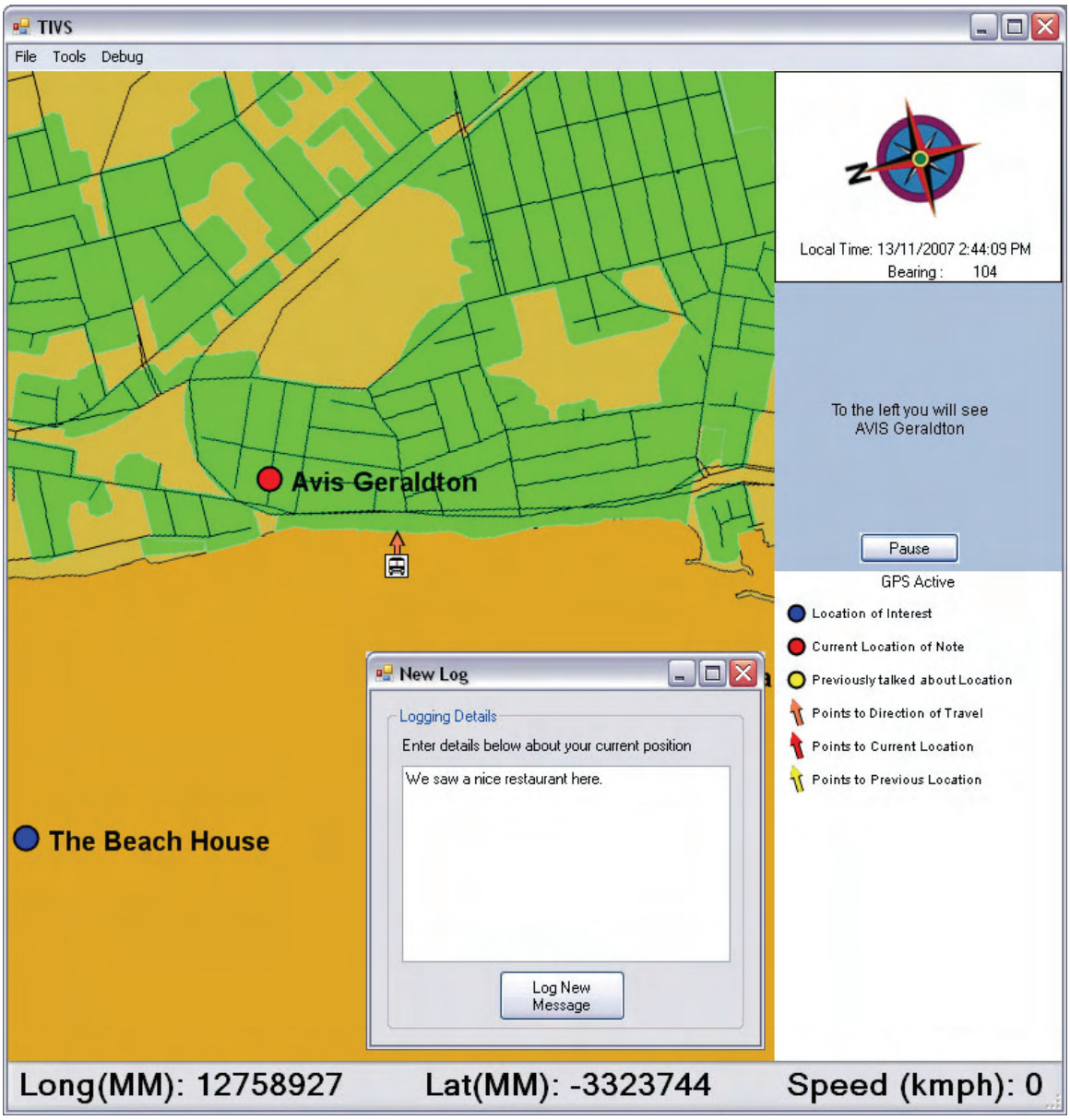


Figure 8: Logging Information on your Location

Post-Tour

During the tour the system records the POIs and items mentioned. A routine allows the driver to download this information onto a USB key and give it to the tour company. The tour company can then use this information for post-tour support. For example, it could be used to create a PDF showing the location of POIs mentioned. The PDF could also include a list of POIs and the relevant URLs. Members of the group could download this document via the Web. Such PDFs could be updated once a day and users could select their particular tour based on tour name and date. These URLs could allow tourism organisations to check who provided the links and so give discounts to the bus/tour company. Other options for post-tour support would be to produce CDs or DVD of the tour (audio, text, images, video etc.).

Chapter 5

MODULES

TIVS is made up of the following modules/layers:

- Look Ahead Algorithm
- Map Display
- GPS Reading
- Data Access
- History
- User Interface
- Data Creation
- Data Update
- Speech
- Database Structure
- Video
- Music
- Data Entry Application
- Website

See layer diagram (Figure 9) and data flow diagram (Figure 10).

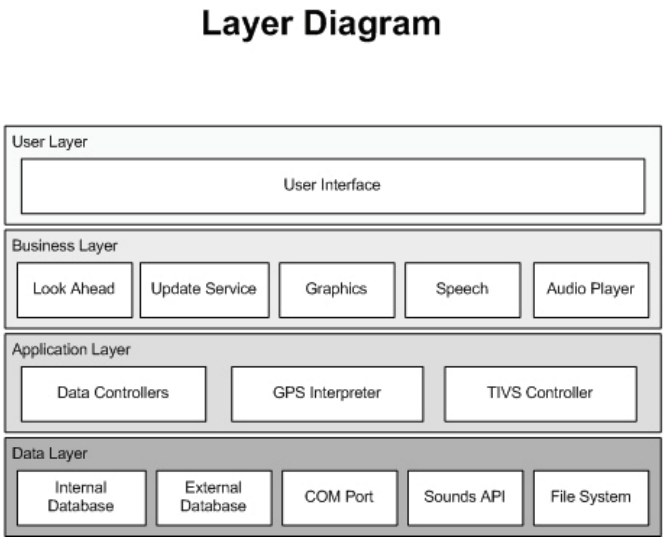


Figure 9: Layer Diagram

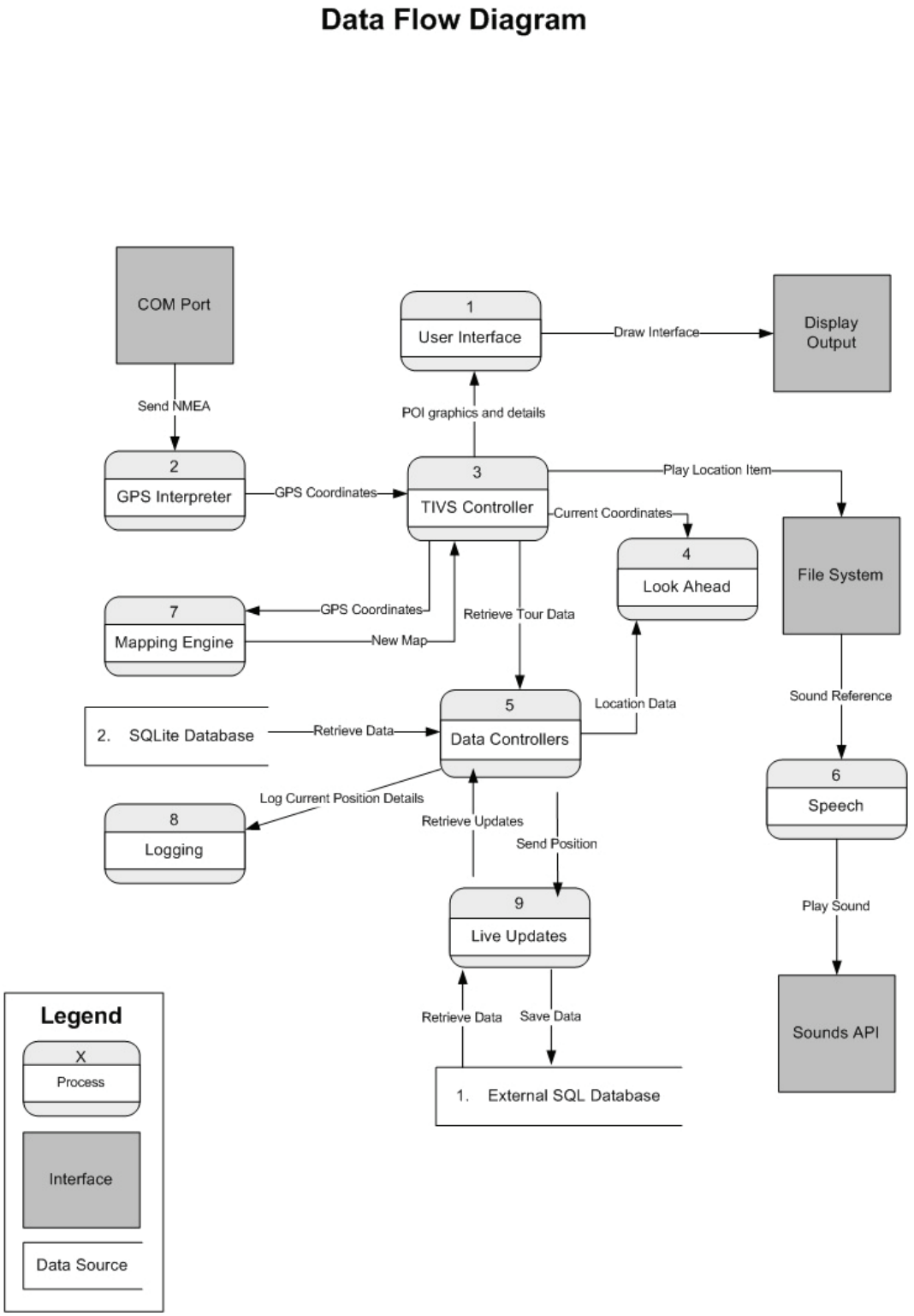


Figure: 10. Data Flow Diagram

Chapter 6

SPECIFICATIONS OF TIVS MODULES

Look Ahead Algorithm

Role:

- To decide on the optimum items and locations to mention during the tour

Scope:

- Integral part of system

Problems:

- Complicated
- Hard to work out
- Will take a number of years of use to fine tune

POIs and items to be mentioned in the commentary are arranged in a queue and the forward looking algorithm is updated when the item has finished talking (or every 15 seconds) and the queue is changed. The system will work out which POIs and items/attributes to place in the queue. Factors used to calculate which POIs are to be included in the queue and their ranking are:

- the location's default value (-10 to +10)
- the tour type modifier
- bearing (eight directions)
- other factors (see Appendix A)

The values of each of these factors will be mathematically combined. Negative numbers will result in POIs being less likely to be included in the commentary. The factors used to determine which items/attributes are mentioned for each POI and their rank are:

- the location's final value (location's rank)
- location item's tour type modifier
- …

There are around 30 factors which can be used and the algorithm relies on very precise trigonometry (see Appendix B).

It is the overall weightings of items that will determine how many items are mentioned for each POI. Once a location item's weighting is less than the weighting of the next first item, that POI will stop being discussed and the commentary on the next location will begin (see Appendix A). Items will be listed in the queue in the order in which they are recorded in the database (unless the order is out-weighted by tour type). There will also be the option to view POIs and items in the queue and their rankings as a list (for developers). Tour companies will be able to adjust the above values for ranking features and their attributes. A default/general tour type is also needed for when a tour type is not specified.

It is the tenacity value that determines how far ahead the system will look. The default tenacity value is 12 – 8 x 15 second slots or two minutes. The path of the bus is divided into 15 second slots as each item in the commentary goes for up to 15 seconds (it assumes the bus will continue to travel in the same direction at the same speed). The tenacity value helps manage the items to be inserted in the queue. The look ahead algorithm will try to fill the entire queue up to the tenacity value. The tenacity value affects the quantity (commentary density) and accuracy of information delivered.

Speed is another important factor impacting on the features and items mentioned. The speed and direction of the vehicle/user is calculated every few seconds. The algorithm will also assume the bus will continue to move in the same direction as the last two GPS points.

The zoom level for the notebook version depends on the speed of the vehicle and features to be included in the commentary (i.e. in the queue). The zoom level for a highway will be larger than that for local streets. There are three zoom levels—level 1 2 km across, level 2 20 km across and level 3 80 km across (overview map).

The tour company/data entry person will enter a throw distance for each POI. The minimum throw distance will be 100 m and the maximum 40 km (for a large feature such as a mountain) —a recommended minimum and maximum which can be altered. The throw distance is important for determining the area within which a POI should feature in the commentary. One problem with the use of a throw distance, of course, is having a statue or other feature with a large throw on the other side of a building so it is out of view, but still within the throw distance to feature in the commentary.

For features with a large throw (long range locations), the system will wait until the queue is empty or there is enough space, before inserting it in the commentary. If the user is within the throw of the long range feature and the system has nothing else to say, it will comment on the long range location straight way, otherwise it will wait. If the system has nothing to else to say, it will look for 10 items to comment on (i.e. comment on all items for that feature). The closer the user is to this feature, the less space it looks for when trying to insert the POI into the queue (e.g. at 10 km the system looks for 10 spaces, at 9 km it looks for 9 spaces, at 8 km it looks for 8 spaces etc.). When the user is within 5 km of a long range feature, it is treated as a normal feature/POI (see Appendix A).

Whenever there are large gaps in the commentary, music or general interest commentary (e.g. on Sydney) will start up, for example, in areas with a low density of POIs such as regional areas. This general interest commentary will contain up to 100 items and each item is said only once, although the commentary can be said at any time. Hence, items of the general commentary mentioned in a previous period of silence will not be repeated the next time the general commentary starts up again (on a single tour). Instead, the general commentary will start where the commentary stopped in the previous gap.

The commentary for each feature is also only said once per tour, so if you travel straight past the POI again later on the same tour, the commentary is not repeated. Currently the system only supports short sound bites, although in future longer sound bites will need to be incorporated, in order to allow narratives on particular regions and POIs.

Display

Role:

- Drawing information on the screen
- Rotating map
- Converting POIs to screen coordinates
- Pointing arrows to last and current POI
- Displaying the location of the bus
- 3 zoom levels
- Dynamic visualisation

Scope:

- Integral part of system

Problems:

- Speed of drawing
- Synchronisation of rotation, data and images

TIVS uses MapWinGIS to display shapefiles converted to Mercator coordinates. This module then also must display/render the information on the screen and show the location of the user/device (derived from GPS). This module was written in-house.

GPS Reading

Role:

- Serial handling of GPS readings
- Reading the current location of the bus/tourist and converting the coordinates to Mercator coordinates
- Auto find for GPS devices

Scope:

- Input only
- Integral

Problems:

- Handling outliers
- Obscure hardware setups
- Different devices
- Different sentence structures
- Serial port buffering
- GPS device drop out from being unplugged
- Computer going to sleep
- Uses Mercator coordinate owing to the problem of crossing UTM zones

A threshold GPS error has been defined, so that locations within 10 m are treated as coincident. GPS however, will not work in museums (i.e. inside a building).

Data Access

Role:

- Used a third party database access layer developed by Faraday Media
- Interface for retrieving and saving data
- Allows abstraction from data source, so when the data source changes there is no need to change the logic

Scope:

- Integral

Problems:

- Size of sound files
- Size of shapefiles when rendering

History

Role:

- Post tour support
- Records the location of the vehicle, the POI and item ID and time in a trip log whenever an item is being commented on
- Trip log recorded in SQLite
- Very simple table structure
- At the moment it is mostly used to help with the development phase and debugging
- Can download to USB

Scope:

- Not integral
- Just a value added service

Problems:

- No major issues
- The best way to get this information to the user. Making it user friendly is time consuming

User Interface

Role:

- Allows users to record information on their current location
- Allows users to change zoom levels
- Allows users to view their location on a map and the location of POIs
- Allows users to view summaries of POIs, coordinates etc. on screen
- Contains maps, menus, text, coordinates etc.
- Allows users to pause the application
- Allows users to choose to hear either music or general interest commentary during gaps in commentary
- Updates every three seconds

Scope:

- Integral

Problems:

- Written in C#

Data Creation

Role:

- Preparing the map data to be displayed (data manipulation)
- Creating the maps to be displayed in ArcMap
- Defining general interest areas (non-overlapping boxes which equate to tourism regions)
- Recording sound scripts and putting them in appropriate directories
    - Text-to-speech will be implemented

Scope:

- One off process

Problems:

- Defining general interest areas
- Finding sample data
- Level of generalisation of data—to minimise storage
- Selecting symbolisation—colour, line width etc.
- Dynamic label placement
- No real interface was created so it was time consuming to create test data

Data Update

Role:

- Synchronises location item and online computer
- Allows users to receive real-time updates via GPRS
- Text-to-speech implemented
- Updates locations, items and sounds written in-house

Scope:

- Not integral
- Needs to be done periodically for consistency

Problems:

- How to handle a connection drop out
- Distances between updates (e.g. in Outback)

Speech

Role:

- Interface to text-to-speech engine
- Text-to-speech conversion
- Commentary is broken into many parts—broken into different directories according to language, location and item
- Plays direction speech (e.g. to your left is …) on first location item

Scope:

- Integral to system
- Will run without sound

Problems:

- How to handle the saying of sound files
- Volume is an issue in car, resolved using FM transmitter
- Size of sound files
- High cost when professionals are used to generate sound files
- Difficult to alter
- Text-to-speech audio is unnatural, lacks expression etc.

Database Structure

Role:

- The data structure that stores the central repository (Master Table)
- CRC naming conventions used throughout
- Centralised database has enough information to send updates (update modifier values)

Scope:

- One-off process

Problems:

- No identified problems

See Figures 11 and 12.

The master database stores the information/commentary on the various POIs that can feature in the tour. For each POI (e.g. Sydney opera house) any number of attributes can be recorded (e.g. information on architecture, shopping, history etc.). Each of these categories of information are also weighted, so that information can be filtered according to tour group interests. There will be a restricted list of tour types to choose from (history, architecture, sports etc.) and attributes will be differentially weighted according to the tour type. These tour types, categories of information and their weightings, as well as distance (and speed), will determine the audio output (see Look Ahead Algorithm). For example, if the main interest of a tour group is architecture, then the architecture information will have the highest weighting and will always feature in the commentary for that particular tour ahead of other attributes. The commentary for each category/attribute will be up to 15 seconds per attribute. The title of a POI will also be treated as an attribute and will always be said before other attributes are mentioned.

The tour company will enter the tour types to be supported and choose the POIs, attributes and their weightings for the different tour types. They will also need to enter a throw distance for each POI. It may take some time to refine these specifications—tour types, weightings, throw distances etc.

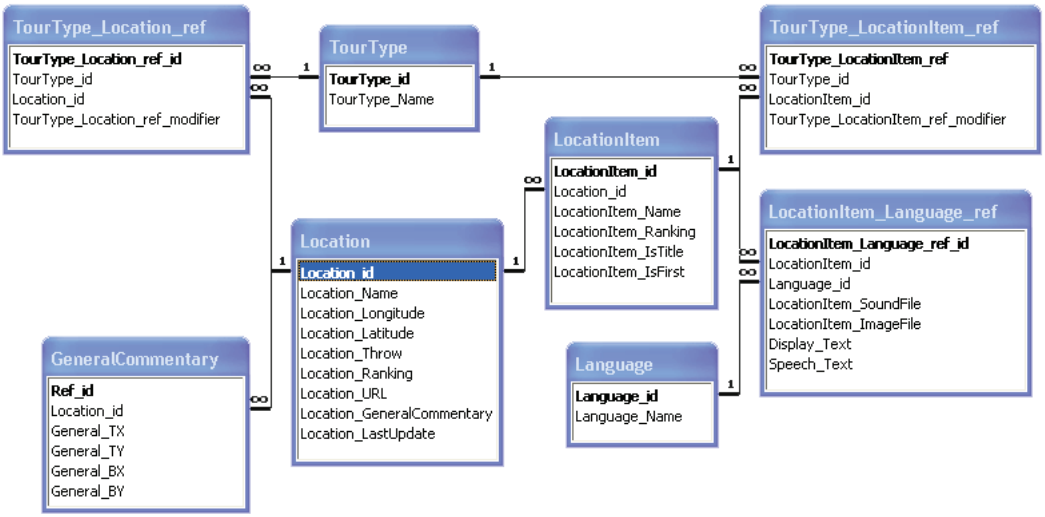


Figure 11: Laptop Local Database Entity Relationship Diagram

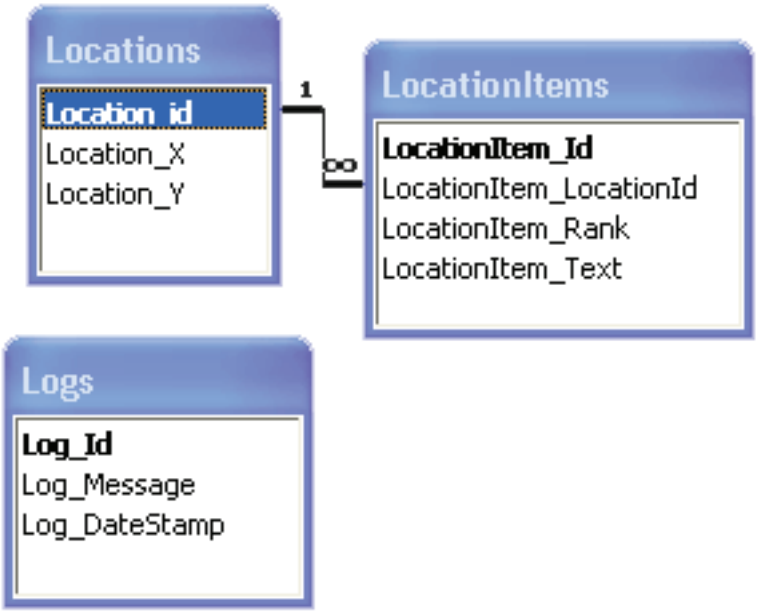


Figure 12: Sandbox Database Entity Relationship Diagram

Video

Role:

- To allows tourists to view short videos during the tour, particularly when there are gaps in commentary
- Users can choose from 10 minute, 20 minute, 30 minute or 1 hr videos
- Supports DivX and MPEG
- Uses Windows Media Player

Scope:

- Not integral to system
- More important in rural areas where there are large gaps in commentary

Music

Role:

- To allow background music to be played is periods of silence (over 2 min)
- Music stored as a large number of MP3 files
- Randomised selection of music using Windows Media Player
- At least 1 hour of music

Scope:

- Not integral
- Fills in gaps in commentary, which is particularly important in rural areas

Problems:

- Need a large number of music files, otherwise the same songs are repeated often. This is a significant issue when there are long gaps in commentary
- Random selection can result in the same songs being repeated many times

Data Entry Application

Role:

- Application for entering general interest commentary
- An application for entering data on POIs (text, sound files and images)
- Users begin by entering tour types (e.g. architecture, history, gardens etc.) and then enter information on POIs (see Figures 13 and 14)

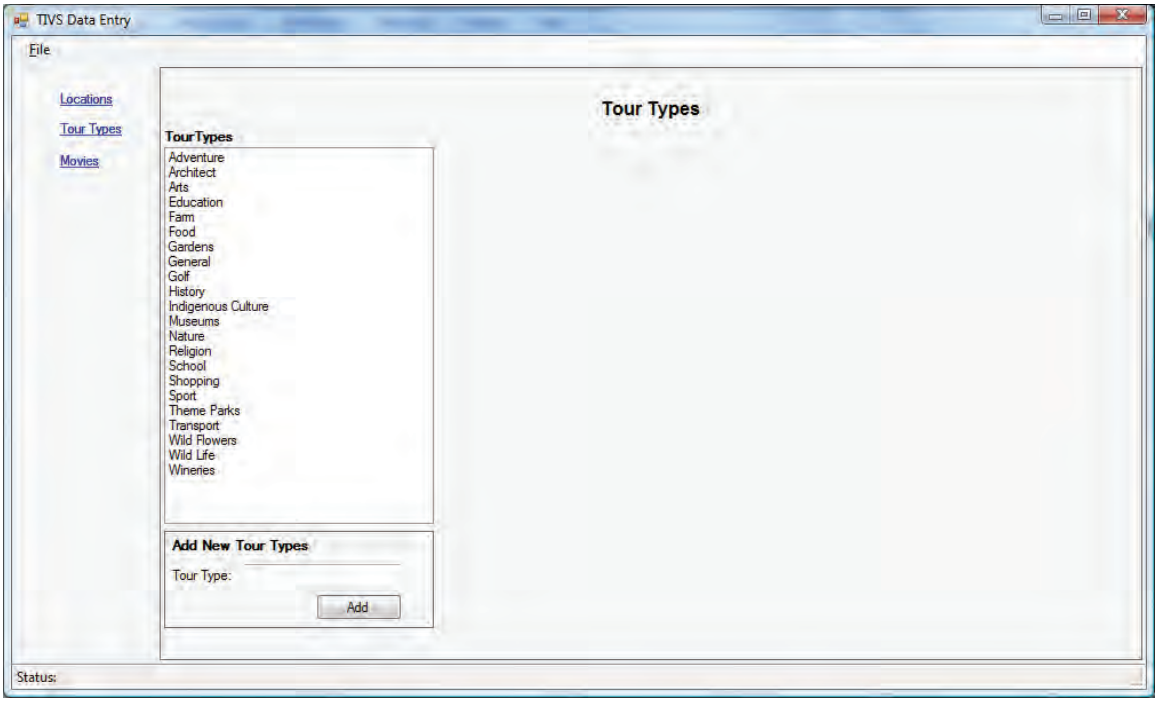


Figure 13: Data Entry Application–Tour Types

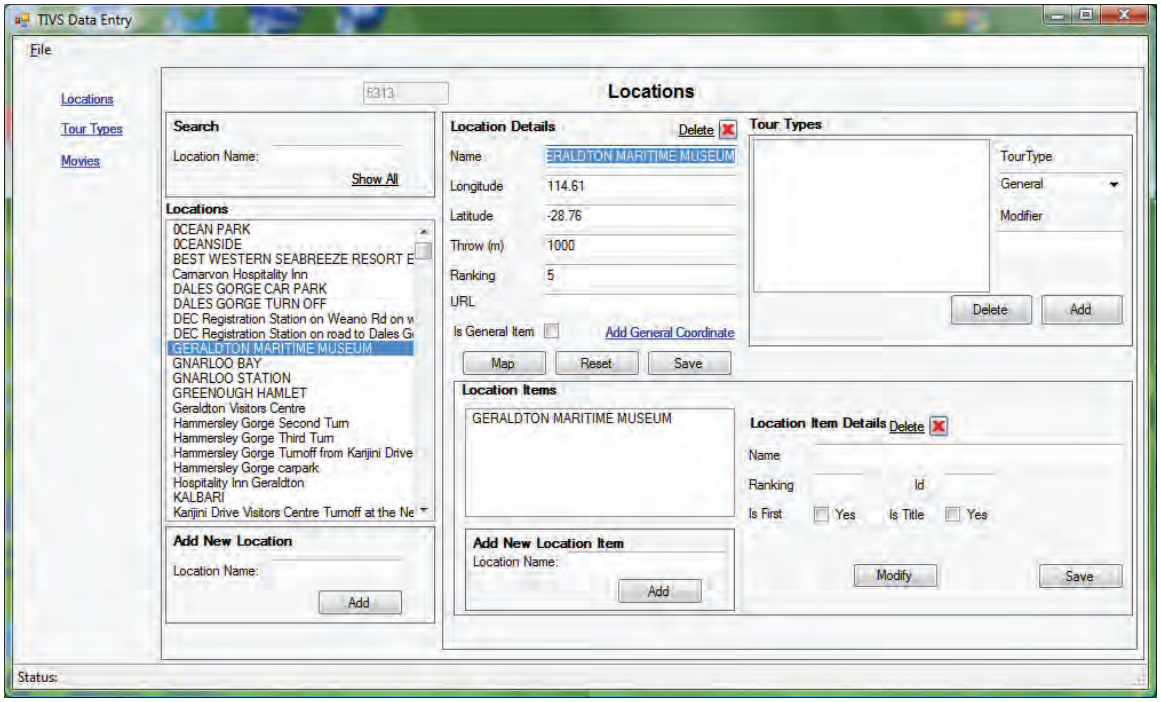


Figure 14: Data Entry Application–POI Data

- For each POI the tourism organisation must enter the name of the POI, coordinates, URL and ranking. Then the relevant tour types and modifier must be entered (the modifier is how important the POI on a scale of 1 to 10, with 10 the most important)
- Any number of items (commentary) can be entered for each POI. The title of the POI is also recorded as an item. Each location item has a name and ranking (on a scale of 1 to 10, with 10 the highest)
- For each location item display text must be entered (text displayed on the TIVS interface) and also the text to be said
- Relevant tour types and modifiers are recorded for each item
- For each item, commentary can be entered as an MP3 file (recommended) and an image can be recorded (see figure 15)
- This is also the interface for entering videos that can be viewed during the tour (DivX and MPEG) (see figure 16)

Scope:

- Integral to system

Problems:

Text-to-speech engine is used to convert text to audio if no audio files (MP3) are stored for an item. This results in commentary which is unnatural, lacking expression etc.

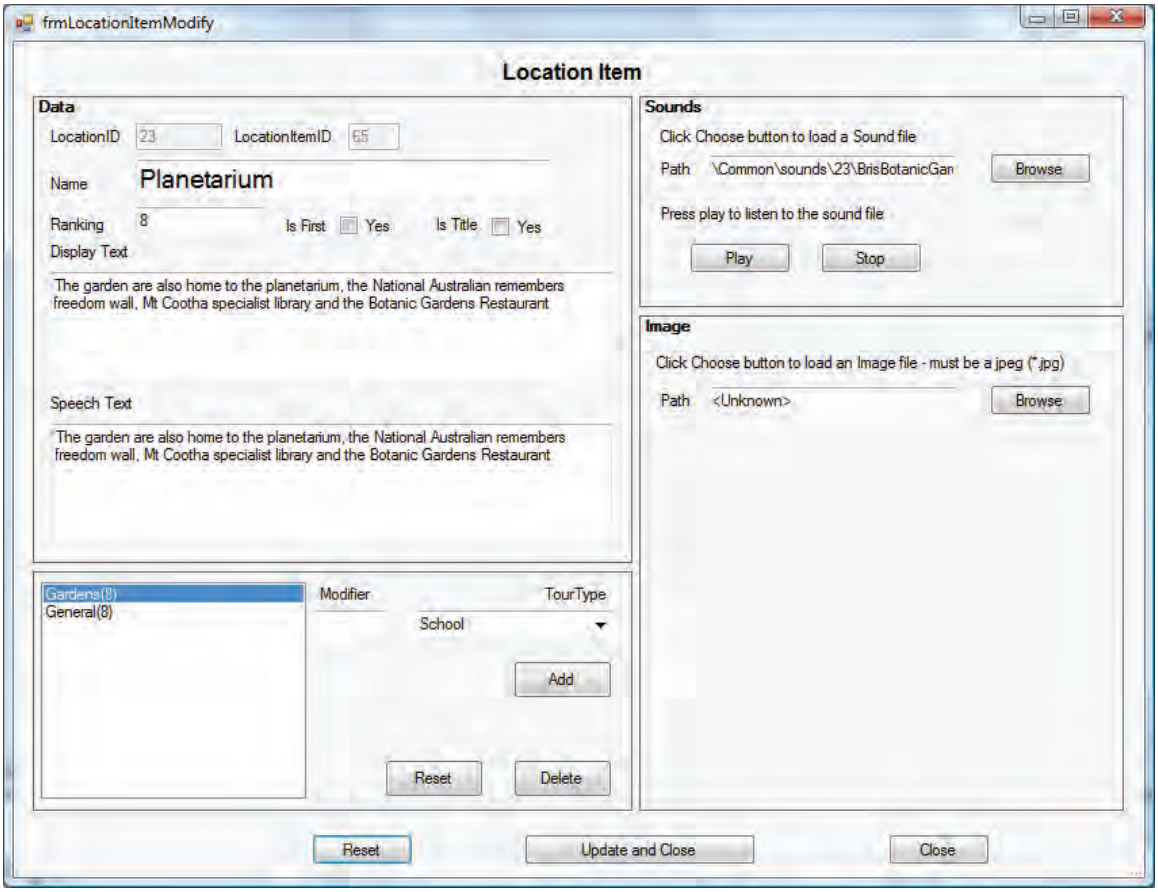


Figure 15: Data Entry Application–Location Items

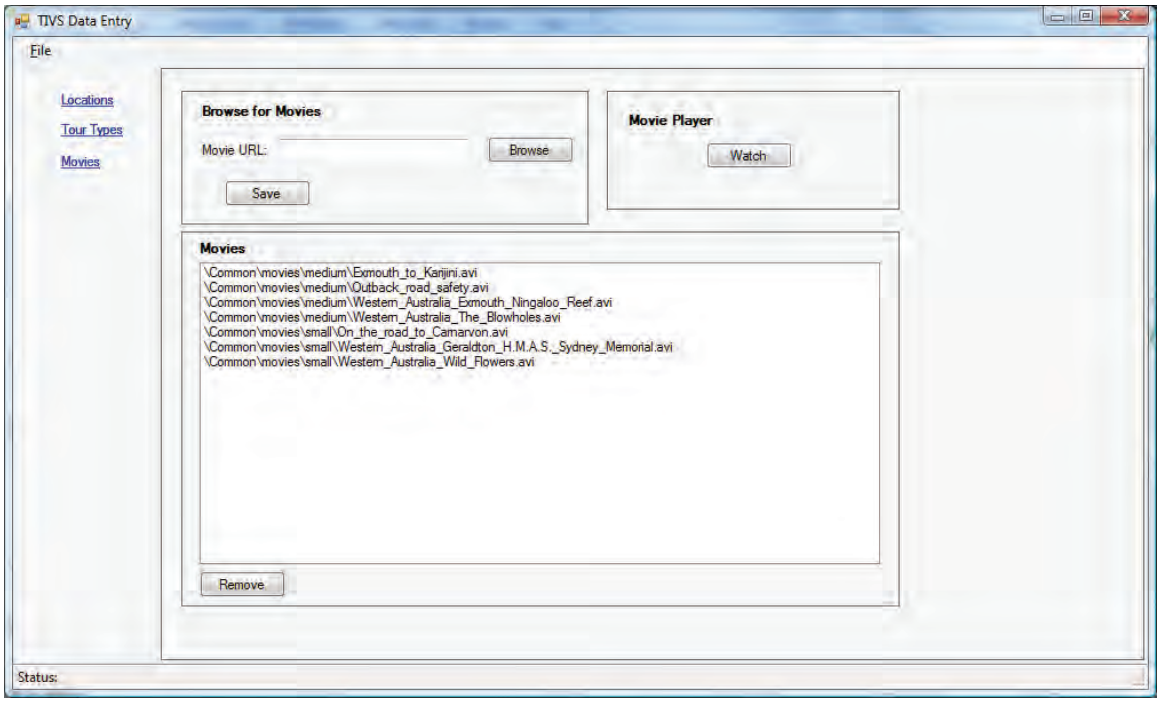


Figure 16: Data Entry Application–Videos

Website

Role:

- Allows access to real-time updates via GPRS
- Users can download and upload GPS tours

Scope:

- Not integral to the working of TIVS, but is a key feature of TIVS

Problems:

- GPRS coverage is limited in rural areas
- How far ahead to look for updates, especially in rural or outback Australia when there are large areas without coverage?
- Size and shape of shape of search area

Chapter 7

ISSUES

There were quite a few challenges/problems faced in the development of this prototype. The first of these relate to the limitations of mobile devices such as laptops:

- Limited battery life (2–3 hours)
- Resolution for the bus tour—we assume a minimum resolution of 1280 x 1024 ppi.

Bus screen size is another issue (minimum requirement of 17 inches) as people need to be able to see the screen from the back of the bus.

The use of GPRS for real-time updates is also problematic. First of all, mobile phone networks have less bandwidth, more latency, less connection stability and less predictable availability (Peng & Tsou, 2003, p. 467). GPRS only allow for up to 115 kbps. Coverage is another major issue as without coverage users cannot access real-time up-to-date information and must rely on locally stored data.

The use of GPS also results in a number of limitations:

- GPS will not work inside buildings. In such a case, Wi-Fi or Bluetooth could be used for locating the mobile device
- Limited positional accuracy (around 10m)
    - The accuracy of the user's location is also affected by map scale
    - A threshold GPS error has been defined, so that locations (GPS readings) within 10m are treated as coincident
- Problems in urban environments (e.g. urban canyons)
- Users must have a GPS receiver (connected to laptop via USB or Bluetooth)
  Mobile cartography also involves different requirements and constraints to traditional cartography:
    - Requires very simple, generalised, uncluttered, dynamic and interactive maps
    - Issues of symbology (high colour contrast; widely recognizable symbology etc.), label placement etc.

Other issues are more application-specific:

Look ahead algorithm

- Which factors should influence POI and item ranking?
- How should the system calculate which location items to include in the commentary (i.e. how to fill the queue)?
- How far ahead to look?
- How to handle features with a large throw distance?
- What to do when the vehicle turns away from a feature that was to be incorporated in the commentary?
- Relies on precise trigonometry
- Commentary density is an important issue; the tour company is unlikely to want long periods of silence in regional areas; in urban areas the commentary will be very dense and it may not be possible to include all POIs
- For real-time data updates, it is necessary to send the updates ahead of time, so they are already in the system before the vehicle arrives at the relevant POI for example,. as the bus approaches Dreamworld the system checks the GPRS signal and sends the updated information to the notebook. The system must work out what information to send to the bus (location specific) and send it ahead of time
- Map data for the commercial version of the prototype will need to be obtained by STCRC
    - Problem of reselling data

Chapter 8

EVALUATION

Field testing of the commercial prototype was carried out in Brisbane and in Western Australia, and the application performed very well. Field testing in Brisbane was undertaken largely in the Graceville area, driving in a car, and walking around the park. The application was installed on a notebook computer and required a vehicle (and a driver), USB or Bluetooth GPS, headphones (or speakers), GPRS mobile phone and data connectors. While a few small issues were identified, they were quickly rectified, and TIVS was deemed to be ready to be tested during a six day trip in Western Australia.

Testing was undertaken under the assumption the prototype was designed specifically for a bus tour. For this reason, the interface was designed to be read from some distance away; the map data was very generalised; roads, railway lines etc., were merged together; roads and places were not labelled; minimal text was put on screen; the interface allowed for minimal interactivity; and so on. It was not, however, tested in an actual bus (although this was the original intention of the Western Australia trials).

Initial field testing in Western Australia was undertaken during a four hour tour of the Swan Valley (visiting wineries, the Margaret River Chocolate Factory, Guildford Hotel etc.), See Figure 17.

Figure 17: Field Testing in Swan Valley

This trial was undertaken in a 4WD and TIVS performed very well. It was also used as a data collection exercise, with data collected on POIs (coordinates, photographs, video etc.). This material could be used by TIVS in the future and was also used by Drive Western Australia to create a podcast of the trial.

Secondly, TIVS was tested during a six day trip from Perth to Exmouth and back to Perth. While this commercial prototype was designed for bus tours, testing in Western Australia was undertaken for tag along tours or global gypsies type tours. Testing was undertaken with Drive Western Australia and these are the types of tours they envisage TIVS being used for. Hence, testing was undertaken in 4WDs with TIVS being used in two of the three vehicles (see Figures 18 and 19).

Figure 18: TIVS Setup in 1 4WD

Figure 19: Field Testing En-route to Exmouth

As the interface was designed for bus tours, so users could view the screen from the back of the bus, several changes are required for tag along type tours in a 4WD.

- Places and roads should be labeled.
- Map data is too generalised.
- Roads layer must be split up into streets, railways etc.
- Interface should have a legend and scale.
- Users should be able to click on places to find out more information—interactive
- Symbolisation needs to be to be changed—colour, line thickness etc.; user's should be able to choose different modes offering different symbolisation.
- Interface should include how far traveled.
- Users should be able to zoom in and out.
- Head phones cannot be worn by drivers and are not essential.
- FM transmitters improve sound quality.

Initial testing was undertaken in the Swan Valley and TIVS performed extremely well in this local environment. Some issues identified were:

- Throw distances entered were too large and need to be tested (suitable distances vary according to the type of POI and topography). It will take some fine tuning to get this right.
- Pre-recorded MP3 files were the better means of delivering audio commentary, as text-to-speech was not natural, missed emphases, was too fast etc.

After initial testing in the Swan Valley, TIVS was then evaluated during a six day trip from Perth to Geraldton, Carnarvon, Exmouth and back to Perth. This is a typical trip that Drive Western Australia would expect tourists to do from Perth and took in attractions such as the Pinnacles (see Figures 20 and 21).

Figure 20: The Pinnacles

Figure 21: HMAS Sydney Memorial

Most tourists would spend at least a week travelling, so the time frame was very realistic. It covered a range of different environments, with varying densities of POIs. The fact that it was employed in Outback Australia also made us very aware of the difficulties of using TIVS in such remote areas. As with the Swan Valley test, this trip was also used to collect data for TIVS and to collect data for the podcast.

Figure 22: Data Collection in the Cervantes

The following issues were identified during this six day trip:

- Battery life of the laptop and GPS was an issue, unless the vehicle had an inverter. Car chargers were also important, but only one device could be connected at a time.
- Inverters and car chargers can only charge while the engine is on.
- A ruggedised notebook is required.
- Size and weight of notebook could be an issue, especially when on a person's lap (better to mount device in the vehicle).
- Volume was an issue in the car, until we used an FM transmitter (another device needing to be charged).
- Heat emitted by notebook. This is a significant problem if the notebook in on someone's lap.
- GPS device drop out from being unplugged and the computer going to sleep.
- Loss of Bluetooth connection between GPS and notebook (unstable).
- Number of cables required—GPS connection, notebook recharger, FM transmitter, camera etc.
- Recharging devices at night—GPS, notebook, FM Transmitter etc. (a problem if camping).
- Large distances between POIs in the Outback (large areas with no commentary).
- 4WDs are very bumpy and it was difficult to click on buttons under such conditions (buses are more stable).
- Need additional commentary on areas where POIs might be (e.g. 'whales can often be seen along the coast ahead' or 'you are entering a wild flower area') —area rather than point features.
- Distances between updates is a significant issue—GPRS coverage is often only available in the towns in the Outback and so updates for all possible POIs ahead (before the next location where GPRS coverage is available) need to be obtained whilst coverage is available. How should this search area be defined?
- Other means of obtaining real-time updates need to be investigated (e.g. via satellite).
- Road noise is an issue.
- Commentary should include information on topographic features, vegetation, geology etc.
- TIVS should be used to deliver safety information to tourists. This is very important for the Outback.
- The interface should show coordinates in decimal degrees.
- Different environments result in different needs for the traveller.
- It would be useful to include information on hotels.

Chapter 9

BUSINESS MODEL AND FUTURE DEVELOPMENTS

Potential Business Model for Bus Tour Prototype

Revenue will be obtained from tour/bus companies who purchase the application and data (pay per bus installation). They will be given a detailed manual on how to set it up, enter tour types, attributes, weightings, throw distances etc. They may also choose to have the system set up for them for a fee. Updating and maintaining the system should be done by the tour company/bus company.

For the Bus mode prototype the following possible revenue models are envisaged:

- Cost of application, data, setup and maintenance can be built into the tour price
- Free upgrades?
- Pay per transaction for real-time updates
- Additional revenue from PDF/CD/DVDs of tour (post-tour support)

Potential Revenue Model for Tag Along Tours

- Over the counter sales (e.g. at Best Western Hotels)
- In-line Advertising
- Online sales of the TIVS software and data
- OEM to Hire Car Companies—Targeting Britz

Enhancements Required for TIVS

The following enhancements must occur in order to take TIVS to the next stage:

- Interactive version for 4WD/tag along tours
- Identify suitable hardware
- Incorporate navigation/routing
- Incorporate safety information
- Make TIVS more interactive
- Incorporate information on hotels; online bookings?
- Add data collected during tests in Western Australia to POI database

Chapter 10

CONCLUSION

Location Based Services have already begun to revolutionise the Australian tourism industry, by providing location and time specific personalised value added services to users on the move. Given the consumer driven demand for access to information, services and applications anywhere, anytime, there will be an ever increasing demand by tourists for access to such applications whilst on the move. LBS can support the tourist in all three phases of their activity, especially in the on tour stage. This is particularly important given the changing requirements of travellers today. Travellers today have less time to spend planning a trip, want greater flexibility during a trip, and take shorter breaks more often.

TIVS is a feature-triggered, location aware, multi-lingual tour guide for tour groups and individuals. It uses GIS, GPS and wireless technologies to deliver audio, text, images and video to tourists on the move. The commentary delivered will depend on the interests of the group/individual, their location, speed, direction etc. The significance of TIVS is that it delivers ad hoc commentary based on the location of the traveller and their interests. Real-time up-to-date information can also be received via GPRS.

This commercial prototype of TIVS was developed for tour groups travelling in a local physical environment such as the Gold Coast, Brisbane, tour bus etc. This bus tour version was developed for notebook computers and can deliver personalised audio commentary to the tour group, whether they are travelling by bus, boat, 4WD etc. Provided the vehicle has a screen, tourists can also view their location and the location of POIs mentioned in the commentary on a map, as well as text, images and videos.

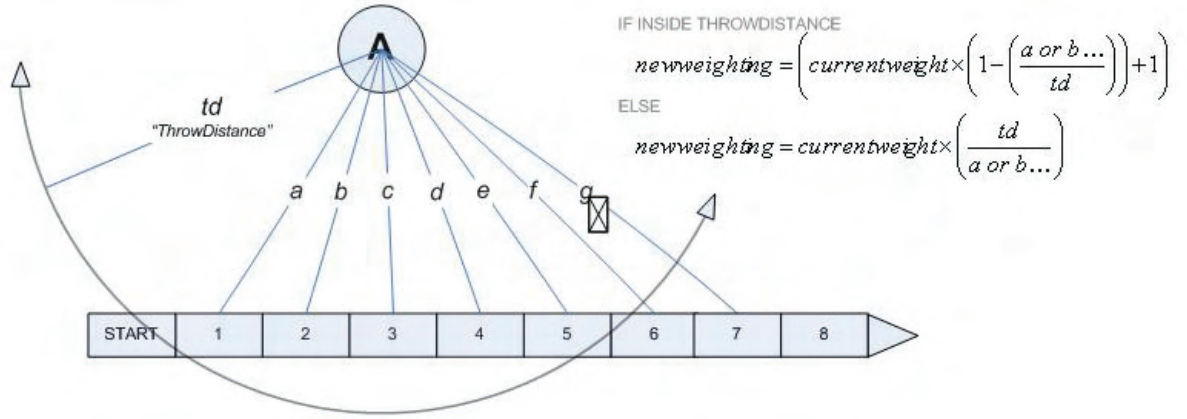
Evaluation of this prototype was carried out based on the assumption that the interface was meant to be seen from the back of a vehicle (e.g. bus). Field testing in Western Australia, however, was carried out for tag along type tours in 4WDs. For this reason, several changes are required to improve the interface for 4WD tours. The six day trip in Western Australia also brought to our attention a number of issues associated with travelling in Outback Australia.

These field tests were very successful and the system performed extremely well. Most importantly, they enabled us to identify a new market for TIVS (4WD tours) and analyse the needs of tourists travelling in 4WDs in remote areas. In order to take TIVS to the next stage, a number of changes need to be made to the application. Future development should focus on the use of TIVS for tag along type tours.

APPENDIX A: LOOK AHEAD ALGORITHM

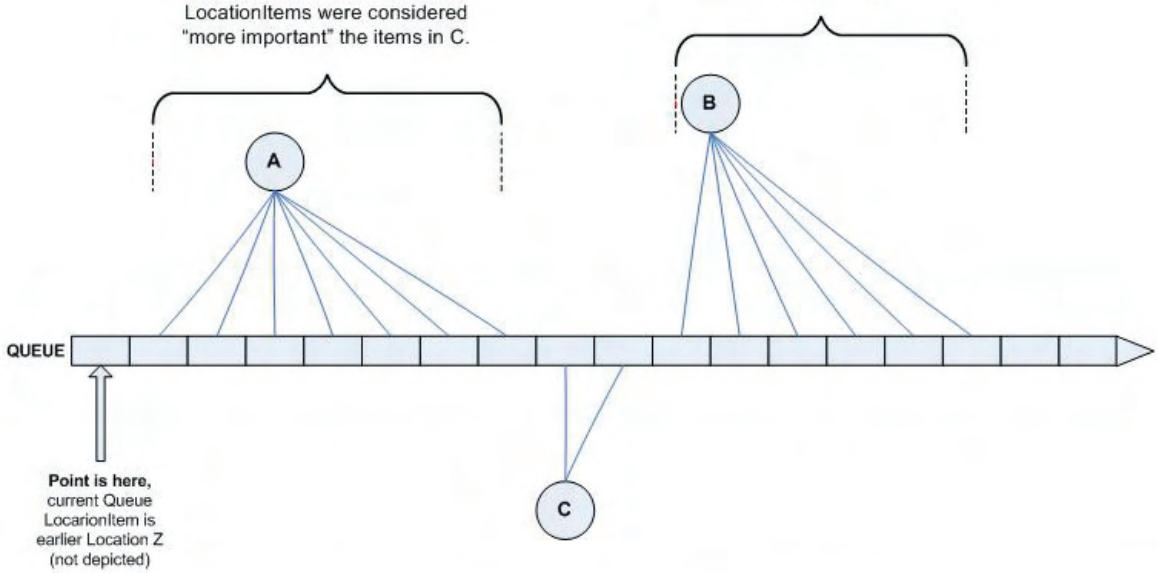
Compared LocationItem Weighting System

In order to reduce the priority further on LocationItems as they leave the ThrowDistance of their Location (so as future points can be inserted into the Queue) LocationItem's will suffer a weighing bonus/penalty depending on their proximity to their Location Coordinates. Once a LocationItem's weight is less then the aggregated weight of the next Location's first item, the Location will be stopped being discussed and the next, higher ranked Location will begin.


A
td
"ThrowDistance"
a b c d e f g
START 1 2 3 4 5 6 7 8
IF INSIDE THROWDISTANCE
$newweighting = \left(currentweight \times \left(1 - \left(\frac{a\ or\ b\ldots}{td} \right) \right) + 1 \right)$
ELSE
$newweighting = currentweight \times \left(\frac{td}{a\ or\ b\ldots} \right)$

LocationItems displayed based on their priority when compared with the next closest Location C. Location C's post modified weight was quite low so many of A's LocationItems were considered "more important" the items in C.

Items toward end of look ahead algorithm are similarly weighted. Location C's post modified weight was quite low so B started inserted its location items quite soon. Since there is nothing immediately after B, it displays all available LocationItems.



Assumptions:
Items with a negative basic weighting (after factoring in TourType modifiers) will not be regarded for potential LocationItems.
Data Entry Operators will have a basic idea about the cause and effects, which changing Location, LocationItem and TourType rankings will have.
LocationItems will occur in the order of which they have been entered and which their Location has been weighed ranked.
GPS Errors will be handled prior to the Look Ahead.
Even when "stopped" the system will pass-through a very minor and incremental vector and heading by 'simulating' a slight move of a few meters

LocationItemTenacity Injection System

The size of the queue (and its minimum fill) helps mange additional LocationItem inserts in to the talk Queue.

LocationItemTenacity is defined by a number (stored in the database) which indicates how far the look ahead should operate.

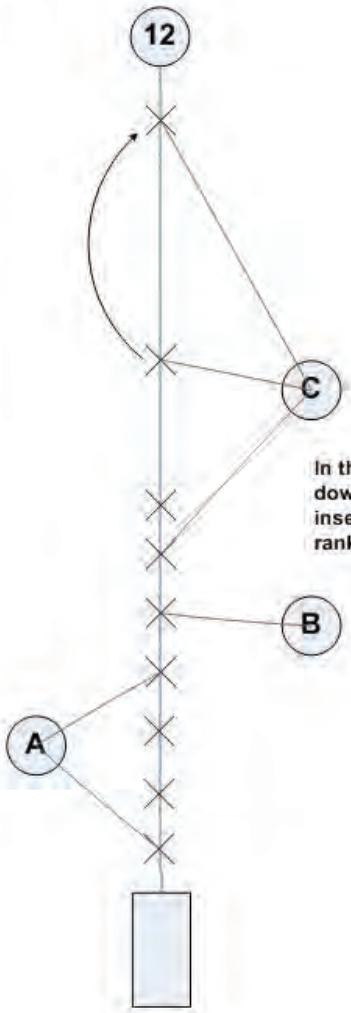
During the look ahead, it will try to fill the entire queue up to the value of LocationItemTenacity. If, after the intial load, it discovers that the queue is not full to the n^{th} index, it will loop through LocationItems not already queued to see if they can be inserted.

This may push some items further along down the queue, however, this effect is intentional.

The greater the LocationItemTenacity, the greater the inaccuracy of the talk queue. The smaller the LocationItemTenacity, the more accurate it will be (but with limited foresight). If the lookahead is too short, however, some LongRangeLocations will not function properly.

Default will be 12.

The LocationItemTenacity will only make a significant impact in or around sparsely populated areas, as dense areas should nearly always fill the queue.



In this example, C can be "moved down" because more of B can be inserted (according to our ranking rules).

Assumptions:
Operators may want to specify both the accuracy and quantity of information read by the system. This number assists us in doing this mathematically.

LongRangeLocations "Best Fit" Algorithm

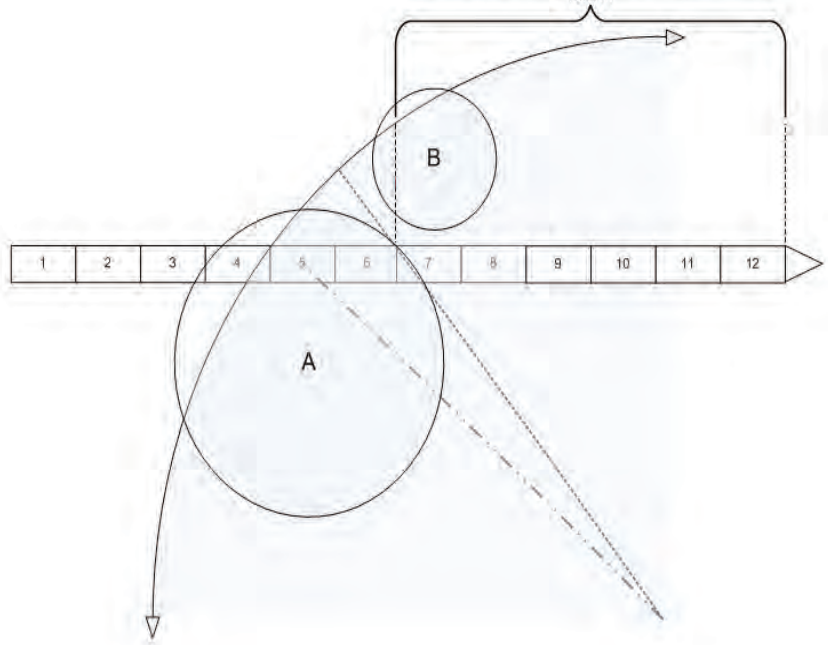
LongRangeLocations are going to be predefined by operators and read from the database. We will default the definition to 5000mtrs.

LongRangeLocations wait until the queue is quite empty before inserting themselves. The closer you are to the coordinates of the LongRangeLocation the less space it looks for when trying to insert the Location into the queue defined by:

IF VECTOR > 10000 THEN LOOK FOR 10 CLEAR SPACES
FOR EACH Km < 10Km SPACE REQUIREMENT - 1
(i.e. AT 6000m look for 6 spaces in the queue)
IF VECTOR < 5000 THEN TREAT AS NORMAL LOCATION

Additional Notation. It may become necessary to later include vector/bearing relationship into the LongRangeLocation "Best Fit" Algorithm, so if the tour starts moving away from the location, steps are taken to ensure the mountain isn't missed.

Initially, however, we will assume that all tours that deviate away from a LongRangeLocation will always return.



Assumptions:
We assume that any given map will only have a limited number of LongRangeLocations, as many overlapping LongRangeLocations may cause processing issues (speed of algorithm).
LongRangeLocations are not considered "urgent" locations as they will generally be easy to view.

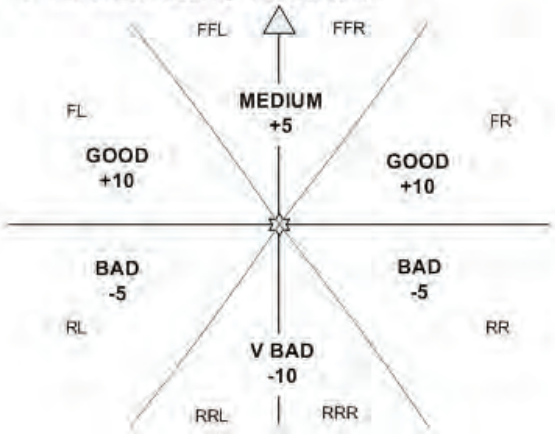
Factors Used to Calculate Ranking

Two ranks will be calculated using a number of circumstantial, pre-inputted and pre-defined factors to determine the best way to order the talk queue.

To generate a list of ranked Locations use the following factors:

A The Location's Default Value
B The Location's Tour Type Modifier
Nb. A and B will be added and given to the look ahead algorithm as a single integer number

C The Current Bearing on the Location



D The formula $\frac{vector}{10}$ to get a factor of distance

E Throw distance: Shorter throws are more important because there is less chance of picking it up in a later part of the tour.

To generate a list of ranked LocationItems use the following factors:

A It's Location's Final Value
B The LocationItem's Tour Type Modifier
C The LocationItem's Default Value

APPENDIX B: CONSIDERED FACTORS

Factors that could be considered in Look Ahead Calculation

The following number of factors could be considered during the look ahead algorithm.

#	Factors	Value	Data Type *	Implemented
A.	Location Default Value	0	Database	Yes
B.	Location Tour Type Modifier	0	Database	Yes
C.	Current Bearing	N/A		Yes
D.	Forward-Left Modifier	+10	Config XML File	Yes
E.	Forward Modifier	+5	Config XML File	Yes
F.	Forward-Right Modifier	+10	Config XML File	Yes
G.	Rear-Left Modifier	-5	Config XML File	Yes
H.	Rear Modifier	-10	Config XML File	Yes
I.	Rear-Right Modifier	-5	Config XML File	Yes
J.	Forward-Left Bearing	45	Config XML File	Yes
K.	Forward Bearing	135	Config XML File	Yes
L.	Forward-Right Bearing	180	Config XML File	Yes
M.	Rear-Left Bearing	225	Config XML File	Yes
N.	Rear Bearing	315	Config XML File	Yes
O.	Rear-Right Bearing	360	Config XML File	Yes
P.	Current Vector Distance (Integer Divided By 10)	N/A		Yes
Q.	LocationItem Parent Value	0		Yes
R.	LocationItem Default Value	0	Database	Yes
S.	LocationItem Tour Type Modifier	0	Database	Yes
T.	Location Throw Distance	N/A	Database	Yes
U.	Point-To-Location Vector Distance	N/A		Yes
V.	System Tenacity	12	Config XML File	Yes
W.	Available Queue (From Last) To (System Tenacity Value)	N/A		Yes
X.	Point-To-LongrangeItem Vector Distance	N/A	Config XML File	No
Y.	Every 10th Second Stopped Vector Distance (To Maximum)	N/A	Config XML File	No
Z.	Stopped State Condition (True/False)	N/A		No
AA.	Queue Item(2) LocationItem Ranking	N/A		Yes
AB.	Throw distance percentage to current GPS-point vector	N/A		Yes

* Please note that while the "data type" column was meant to store these values; in the prototype many of the values were 'hard-coded'.

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Recent grants and key projects are:

- 2002 WebMAIL, $180,000
- ITOL Program of NOIE
- Project Leader
- 2000–2002 Tourism Online
- Getting Value—$700,000
- Funded by DISR, CRC Tourism Project to develop SMTE manager skills in information technology. Project Leader. 1999–2001
- Decipher Prototype $1,000,000. Funded by AusIndustry.
- Project to develop an Internet based 'one stop shop' for tourism business information.
- Project Leader. 1999 National Online Tourism Scoping Study $48,000. Funded by ONT.
- To review the opportunities and benefits of online technologies for the Australian tourism industry. Project Leader 1994–1997.
- Animal Health in Thailand and Australia—improved methods in diagnosis, epidemiology, economics and information management $410,000.
- Coordinator of the GIS/IT Component. 1991–1993 Oman—Second Agricultural Census of Oman $8,200,000. Technical Director.

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- 21 years' programming experience; 15 years' GIS experience; 13 years' database experience
- Lectured and tutored undergraduate and Postgraduate courses at 2 universities (contract)
- Has provided technical solutions for over 30 organisations—multi-national organisations, Universities, Federal, State and Local Governments, as well as private and publicly listed companies in Australia for the past 13 years as an independent contractor.

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INDUSTRY PARTNERS

TTF
Parks Victoria
Tourism Western Australia
Tourism Victoria
Tourism Queensland
Qantas
Gold Coast City Council
Department of Environment and Conservation
afta
Tourism NT
Tourism Tasmania
Australian Capital Tourism
South Australia
Tourism New South Wales
Tourism Australia
Department for Planning and Infrastructure
ATEC

UNIVERSITY PARTNERS

University of Technology Sydney
Curtin University of Technology
ECU Edith Cowan University
UNSW The University of New South Wales
UTAS
JCU James Cook University
Griffith University
The University Of Queensland
Murdoch University
Southern Cross University
La Trobe University
Monash University
University of Canberra
Charles Darwin University
Victoria University
Northern Sydney Institute
University of South Australia

COMMERCIALISATION

EC3
EVALUATE COMMUNICATE EVOLVE

EC3, a wholly-owned subsidiary company, takes the outcomes from the relevant STCRC research; develops them for market; and delivers them to industry as products and services. EC3 delivers significant benefits to the STCRC through the provision of a wide range of business services both nationally and internationally.

An Australian Government Initiative

Green Globe

KEY EC3 PRODUCTS

earthcheck
ipat

Chairman: Stephen Gregg
Chief Executive: Ian Kean
Director of Research: Prof. David Simmons

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SUSTAINABLE
TOURISM
CRC

Sustainable Tourism Cooperative Research Centre (STCRC) is established under the Australian Government's Cooperative Research Centres Program.

STCRC is the world's leading scientific institution delivering research to support the sustainability of travel and tourism—one of the world's largest and fastest growing industries.

Introduction

STCRC has grown to be the largest dedicated tourism research organisation in the world, with $187 million invested in tourism research programs, commercialisation and education since 1997.

STCRC was established in July 2003 under the Commonwealth Government's CRC program and is an extension of the previous Tourism CRC, which operated from 1997 to 2003.

Role and responsibilities

The Commonwealth CRC program aims to turn research outcomes into successful new products, services and technologies. This enables Australian industries to be more efficient, productive and competitive.

The program emphasises collaboration between businesses and researchers to maximise the benefits of research through utilisation, commercialisation and technology transfer.

An education component focuses on producing graduates with skills relevant to industry needs.

STCRC's objectives are to enhance:

- the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development;
- the transfer of research outputs into outcomes of economic, environmental or social benefit to Australia;
- the value of graduate researchers to Australia;
- collaboration among researchers, between searchers and industry or other users; and
- efficiency in the use of intellectual and other research outcomes.